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Top of the Range Falcon Approved

Dassault Aviation's latest new Falcon bizjet, the 8X, has received Type Certification from the US Federal Aviation Administration and the European Aviation Safety Agency. The clearances for the French company's new flagship product followed a certification testing campaign that involved 400 flights amassing 830 flying hours. First deliveries of the new tri-jet will take place early in Q4.

The certification testing included a 55,000-nautical mile (101.860km) route proving tour that took in 65 flights to 46 destinations worldwide, including ultra-long range flights from Singapore and São Paulo to Paris, and extreme hot and cold weather environments. The 8X, which Dassault derived from the 7X, is the company's new top of the range bizjet, carrying up to eight passengers and capable of 6,450-nautical mile (11,945km) flights.



Having completed type certification testing, Falcon 8X F-WWOA (s/n 01) will now be used to test Dassault's Combined Vision System and a head-up display, which will be introduced to the 8X in the future. *Katsuhiko Tokunaga/DACT/Dassault Aviation*

Dassault says 12 8Xs are now at the company's Little Rock, Arkansas, completion facility for pre-delivery cabin outfitting work. One of the three 8X flight test aircraft, F-WWOA (s/n 01), will now certify the FalconEye Combined Vision System and dual head-up display that Dassault has developed for the 8X to enhance pilots' situational awareness. *Mark Broadbent*

Swiss CS100 Enters Service



The first Swiss CS100, HB-JBA, will be followed by 14 other CS100s into service with the airline, whose remaining C Series deliveries will be CS300s. *Swiss*

Recent weeks have seen two major milestones for the Bombardier C Series, with Swiss becoming the first carrier to put the CS100 into service and the CS300 variant being certified by Canadian authorities.

Swiss began commercial operations with the first of up to 30 C Series, CS100 HB-JBA (c/n 50010), on July 15 with flight LX638 from Zurich to Paris CDG. The aircraft arrived in Switzerland two weeks earlier, following its official handover to Swiss at Bombardier's Mirabel facility. Swiss will add the CS100 to its services from Zurich to a number of European cities over the summer months. The type will gradually replace the airline's Avro RJ100s over the next year. Swiss has ordered 30 C Series, comprising 15 CS100s and 15 CS300s. Nine CS100s will be delivered to Swiss this year, according to Bombardier executives during a Farnborough International Airshow press conference.

In the same week as the CS100's debut, the larger CS300 received its Type Certification from Transport Canada. Certification from the European Aviation Safety Agency was due a few weeks afterwards, followed later by US Federal Aviation Administration clearance. Rob Dewar, Vice President, C Series Aircraft Programme, Bombardier Commercial Aircraft, described the CS300 certification process as "very straightforward" due to the jet's 99% commonality with the CS100. The first CS300 is due for delivery to Air Baltic in Q4. *Mark Broadbent*

COVER CREDITS MAIN IMAGE: Andreas Loenner LEFT INSET: Pilatus Aircraft CENTRE INSET: Piotr Butowski RIGHT INSET: Piotr Butowski

Airbus Cuts A380 Production

Airbus announced during the recent Farnborough International Airshow that it intends to more than halve production of the A380. This year, the company will build 27 super jumbos, but it will scale down the production rate to just 12 per year from 2018. The decision reflects a diminishing backlog for the type; the latest official figures from Airbus show that of the 319 ordered, 193 have been delivered. Orders have also slowed. The five most recent commitments for the A380 (three for All Nippon Airways, two for Emirates) have been the only firm orders for the jet since 2014.

Despite the rate cut, Airbus remains optimistic about the A380's long-term potential. Its latest annual Global Market Forecast for the next 20 years, released at Farnborough, predicts a need for 1,264 very large aircraft (VLA) of the A380's size class to 2036. Boeing, which with its 747-8I offers the only current direct competitor to the A380, is far more circumspect about VLA demand. Its latest Current Market Outlook envisages only 530 VLAs over the next two decades.

Speaking during Farnborough, Airbus Chief Executive Officer Fabrice Brégier told reporters the company would "be able to sustain the A380" at the lower production rate before ramping up production again in the future. Any future rate rise will naturally depend on a significant increase in orders in the coming years. However, of the 13 current A380 operators, only Emirates has placed multiple repeat orders for the type, which ideally fits its business model of feeding passengers through its Dubai hub. There have also been some cancellations. Air France has dropped an order for two examples and Air Austral has also cancelled its order for two. *Mark Broadbent*

Rare Appearance



British Antarctic Survey DHC-7 VP-FBQ seen after its arrival at Coventry Airport, Warwickshire on July 16. The DHC-7 is in the UK for pilot training at Duxford and demonstrations of a new instrument port. The aircraft is due to return to the Antarctic in September. *Peter Reoch*

Sports Team Superjet

Evgeny Andrachnikov, Senior VicePresident Commerce of Russia's Sukhoi Civil Aircraft Company (SCAC), revealed details of the SportJet variant of the Superjet 100 during a press briefing at the Farnborough International Airshow on July 12. The new model has been conceived to transport professional sports teams between their engagements, combining a comfortable travel environment with services to maximise the potential of the athletes on the field.

Each SportJet will be customised to cater for the specific team's requirements, but the baseline configuration will have a four-zone cabin for between 40 and 50 occupants. Zone one will contain recovery and medical facilities for the players, such as a biomedical couch for physiotherapeutic procedures. In the main team flight zone, they will be able to relax on berthable SMART seats, containing devices to monitor their health – including a bioimpedance sensor, pulse oximeter, data reading and processing unit and airband – as well as personalised multimedia display and control units. Zone three, the coach area, allows strategy to be worked out while en route between fixtures. The team's support personnel are accommodated in the fourth zone. Cabin lighting can be set to the club's colours. No launch customer has yet been identified, but marketing plans include having a 50m (164ft) cabin mock-up ready for display by this year's Olympic Games in Rio, Brazil. As no changes are required from the baseline Superjet 100 airframe, the SportJet can enter production in 2017 and be certified and in service the following year. *David Willis*

Adir Rolls Out

The first F-35I Adir, Hebrew for Mighty One, for the Israel Air and Space Force was officially rolled out from the production line at the Lockheed Martin-run Air Force Plant 4 on June 22. The ceremony was attended by leaders from the Israeli and US governments. Israel's programme of record is currently set at 33 F-35A aircraft acquired through the US government's Foreign Military Sales (FMS) programme. Israel is contributing to the F-35 programme with F-35A wing production by Israel Aerospace Industries; the Generation III helmet-mounted display system by Elbit Systems Ltd and production of centre fuselage composite components by Elbit Systems-Cyclone.

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FCAS

Jon Lake outlines the new European vision for a Future Combat Air System



The two variations of a twin-finned low observable aircraft, of broadly similar configuration to the F-35, incorporating stealth features including fuselage shaping, edge-alignment and jagged, serrated doors, panels and engine nozzles. *All images Airbus Defence and Space*

Airbus Defence and Space revealed tantalising glimpses of a proposed new European/ Multinational Future Combat Air System (FCAS) during the company's Trade Media Briefing in Munich during June 2016.

Airbus Defence and Space is working with the Bundeswehr to define this FCAS, which is intended to replace the capability currently provided by the Luftwaffe's Panavia Tornado strike/attack aircraft, and which is also planned to complement the service's Eurofighter Typhoon tactical fighters, with an in-service date in the 2030–2040 timeframe.

The company believes the FCAS requirement can only be adequately fulfilled by a "system of systems", rather than by a single platform. This would comprise a connected and cooperating set of different types of unmanned vehicles, weapons and manned platforms. (FCAS is also referred to by Airbus Defence and Space as the Next-Generation Weapon System).

When the German FCAS was first unveiled in January 2016 (in an Air Capability Strategy Paper), it was said the central element might be a manned, optionally manned or unmanned platform. Since then, Airbus Defence and Space's studies have shown that unmanned technologies will probably not be sufficiently advanced for the FCAS capability to be provided by a completely unmanned solution, and it is now intended that a new generation manned combat aircraft will be at the heart of the system.

FCAS System Configurations

During their presentations, Alberto Gutierrez, the company's Head of Combat Aircraft and Air Services, and Jana Rosenmann, Head of Unmanned Aerial Systems, both showed PowerPoint slides that included illustrations of the FCAS system, including a next generation manned combat aircraft.

These PowerPoint slides depicted two variations of a basic theme. Both were twin-finned low observable aircraft of broadly similar configuration to the F-35, but with twin engines and a two-seat cockpit; but one had tailplanes and the other did not. Both versions incorporated the same kind of stealth features, with fuselage shaping, edge alignment and jagged, serrated doors, panels and engine nozzles, indicating that low observability is a design driver.

While the tailless version of the design was depicted in a clean, fully low observable, day one of war configuration, with all weapons carried internally, the other version was shown in a non-stealthy configuration, with external fuel tanks and externally carried weapons. The latter aircraft carried wingtip-mounted MBDA Meteor long-range air-to-air missiles, with large drop tanks underwing, and with conformal fuel tanks (or weapons bays, like those on the F-15 Silent Eagle) scabbed on to the sides of the intake ducts.

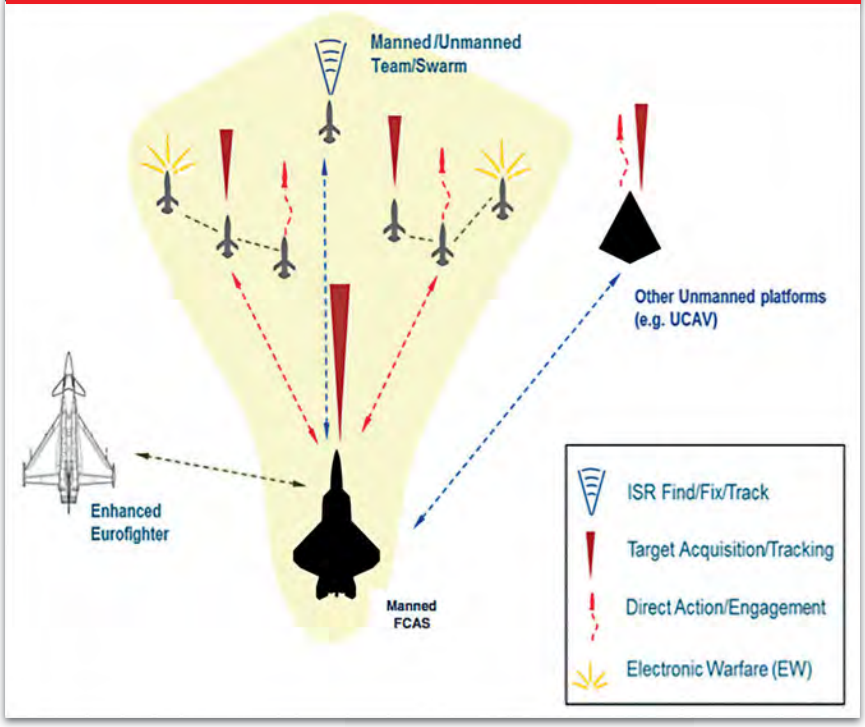
Both variants of the Airbus FCAS design had an intake configuration reminiscent of that of the Sukhoi T-50, with prominent leading edge root extensions (LERX) ahead of and above the intake. These LERX appear to be movable and articulated, like the leading edge vortex control surfaces on the Russian aircraft or on the naval variant of the HAL Tejas LCA.

The European FCAS aircraft appears to be longer and sleeker than either of the American tactical stealth fighters (the F-22 Raptor and F-35 Lightning II), and because of this the aircraft is reminiscent of the new Japanese Mitsubishi X-2 Shinshin (formerly known as the ATD-X), the BAE Systems Replica demonstrator or the Russian Sukhoi T-50.

The sleek proportions of the FCAS aircraft could indicate a greater emphasis on high-speed performance and supercruise, while the large wing area of the new aircraft may indicate that the aircraft has a lower wing loading (and thus a higher degree of agility) than is enjoyed by the F-35.

Both of the Airbus FCAS concept variations were depicted as two-seaters.

FCAS, UCAV AND SWARM



A manned aircraft, working alongside a UCAV and swarms of weapon-carrying and sensor-carrying Mules, is this vision of an FCAS.

Gutierrez said that this reflected the influence of Luftwaffe Tornado aircrew in defining FCAS. It may imply that the new manned combat aircraft will have a nuclear strike role, where the long-standing two-crew principle has always meant that single-seaters are viewed with suspicion.

The two-crew principle may also allow the back-seater to exercise command and control over associated UCAVs and other unmanned systems. These could include swarms of weapon-carrying and sensor-carrying Mules that could be used to extend the view and reach of the manned aircraft.

Gutierrez told AIR International that there had been an ethical discussion about crewing, and that a two-seat configuration meant that decision-makers would be 'on the scene', instead of 'killing at arm's length'.

Mules

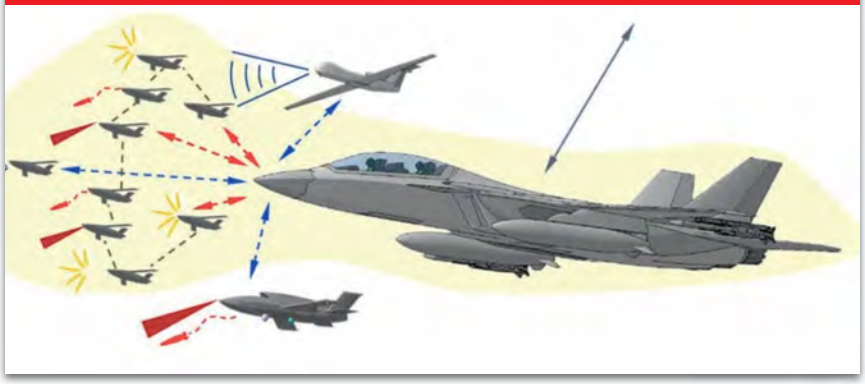
Faced by ambitious and tight timescales and real cost constraints, Airbus Defence and Space plans to incorporate existing programme structures and partnerships into the new project, which it expects to be the product of an international collaboration like the Tornado and Typhoon before it. To control costs further and ensure that deadlines can be met, the new FCAS manned strike fighter will be produced using rapid prototyping and shorter development cycles, and will probably use existing systems and sensors wherever possible, including radar, engines and avionics.

The manned aircraft will be just one element in FCAS, which is intended to be a cohesive, platform-agnostic 'system of systems'. This will connect and integrate a disparate force of cooperating manned and unmanned platforms. While FCAS will include a manned element, and would probably cooperate with other manned allied aircraft, many capabilities will be reallocated from these expensive, complicated, manned platforms to cheaper, simpler and sometimes more expendable unmanned air vehicles (UAVs).

These could include sophisticated long-range unmanned combat air vehicles (UCAVs), various unmanned intelligence, surveillance and reconnaissance and ISTAR platforms, and a host of smaller, cheaper 'swarming' Mules. These Mules would be autonomous, incorporating a high degree of artificial intelligence, and could fly ahead of the manned aircraft and more sophisticated UCAVs, performing a variety of roles. Some would carry sensors for target acquisition, while others would carry weapons to directly engage enemy forces.

In the Airbus Defence and Space PowerPoint illustrations, the Mules were represented by depictions of the EADS Barracuda. Although designed and built as a multipurpose UAV test bed and systems demonstrator, the Barracuda is already a low observable design and could form the basis of an operational UCAV Mule.

FCAS MANNED PLATFORM



The Airbus FCAS concept is intended to connect and integrate a disparate force of cooperating manned and unmanned platforms.

MALE UAV and UCAV

The PowerPoint slides also showed an existing EADS concept to illustrate a medium-altitude long-endurance (MALE) UAV. This T-tailed Future European MALE UAS concept was based on the company's previous Talarion UAV and was first shown in 2013.

The high-value UCAV design shown in the PowerPoint slides was similar in appearance to the EADS Sagitta or X-45A, though the FCAS system could, of course, incorporate any similar advanced UCAV – perhaps a production derivative of the Neuron or Taranis, for example.

If the concept studies now being undertaken by Airbus Defence and Space bear fruit, the resulting aircraft would be the first manned European combat aircraft since the Typhoon and Rafale, as well as being Europe's first fully low observable manned combat aircraft. That is a very big 'if', however, and while a few PowerPoint slides could be a pointer to the future, there is a long way to go before FCAS is fully defined, and there are likely to be many changes – large and small – before that happens.

NASA's Latest X-Plane



NASA said as many as five larger transport-scale X-planes are also planned as part of the initiative that will see the X-57 demonstrate hybrid engine technologies. *NASA*

NASA has revealed its latest X-plane, the X-57. The aircraft will be a converted Tecnam P2006T and will be used to test new hybrid engine technologies. It will be NASA's first new X-plane for a decade.

The X-57 has been nicknamed 'Maxwell' by NASA, after James Clerk Maxwell, the 19th century Scottish physicist who researched electromagnetism. The name reflects the research the X-57 will carry out, into hybrid and electrical propulsion. The original wing and two piston engines will be replaced by a long, thin wing embedded with 14 electric motors (12 on the leading edge and one larger motor on each wingtip). The engines in the leading edge will be used for take-offs and landings; those on the wingtips will be used in the cruise.

NASA said the X-57's purpose is to validate how distributing electrical power across a number of motors integrated with an aircraft could reduce energy usage for a private aircraft. With 'Maxwell' powered only by batteries, NASA also hopes to demonstrate how demand would shrink for lead-based fuel from general aviation, energy efficiency at cruising altitudes, and less aircraft noise. The X-57 project is part of NASA's ten-year-long New Aviation Horizons initiative. The X-57 designation was assigned by the US Air Force.

Mark Broadbent



Tecnam

Aeronautica Militare T-2006s

Three Tecnam T-2006As (military serials MM.55206 to MM.55208) were delivered to the Aeronautica Militare during a ceremony at Tecnam's Capua plant on July 5. The aircraft will be assigned to 70° Stormo, the Aeronautica Militare's basic flying school based at Latina. The wing currently operates the Leonardo-Finmeccanica T-260B to provide basic training for all Italian and some foreign military students.

Tecnam announced it had won a contract to supply three P2006Ts to the Aeronautica Militare on December 21, 2015, following a two-year evaluation. The contract also includes a flight simulator, pilot and technician instruction, three years of technical support and 3,600 flying hours.

The Aeronautica Militare awarded Tecnam the contract to meet the needs of the new Integrated Pilot Training System 2020 syllabus; more specifically, for trainees selected for multi-engine aircraft. Under the new syllabus, trainees will complete their initial basic flying training on the T-260B, continue on the T-2006A before completing their basic training on the higher performance Piaggio VC-180 at the Centro Addestramento Equipaggi Multi Crew (CAEMC, multi-crew training centre) at Pratica di Mare. Previously, students moved straight from the T-260B to the VC-180 which was a significant change in performance characteristics.

Some 70° Stormo instructor pilots have already qualified on the new T-2006A, and the first class comprising five students started in July. *Riccardo Niccoli*

Polish F-16s Deploy

Four Polish Air Force Block 52+ F-16s arrived in Kuwait on July 5 for the first ever foreign combat deployment undertaken by the air force with the type. Polish president Andrzej Duda approved the deployment on June 17; the authorisation lasts for six months until December 31. Dubbed PKW Kuwait, the four fighters equipped with UTC Aerospace DB-110 reconnaissance pods and 150 personnel form one of two military contingents (the second is a 60-man special forces unit) sent to the Middle East in support of the US-led Operation Inherent Resolve. The Polish Air Force component will undertake reconnaissance during its tenure in the Gulf.

The four F-16s were flown to Kuwait with air refuelling provided by a Royal Netherlands Air Force KDC-10 tanker.

More Orders as Testing Progresses



Manufacturing of low-rate initial production (LRIP) batches 3 and 4 (20 aircraft) of the US Marine Corps' Sikorsky CH-53K King Stallion heavy lift helicopter is likely following the issue of a request for information (RFI) on June 13.

The CH-53Ks built in batches 3 and 4 will be delivered in FY2019-2024 and be the last LRIP aircraft. Full-rate production of 168 aircraft will follow to meet the current programme of record for 200 CH-53Ks.

First flown in 2015, in June the CH-53K flight test programme included a demonstration of its ability to lift a 6-ton (5,443kg) external load. The test programme also includes carrying a 13.5-ton (27,000lb/12,246kg) underslung load for 110 nautical miles (200km). On June 23 Sikorsky announced a CH-53K test aircraft had successfully completed an external lift of a 27,000lb payload at Sikorsky's Development Test Center in West Palm Beach, Florida. The aircraft executed an out of ground effect (OGE) external load test at 100ft (33m) above the ground while performing hover manoeuvres to demonstrate its control authority in the flight regime. Out of ground effect is defined as an altitude greater than the helicopter's main rotor diameter (79ft/24m in the King Stallion's case) where power demand greatly increases due to loss of the benefit of ground effect. An OGE load is the most stressful lift condition for a helicopter from a power required standpoint.

The CH-53K is scheduled to undergo an operational assessment this year and its Milestone C review (to initiate full rate production) in 2017. Initial operational capability is scheduled for 2019; Marine Heavy Helicopter Training Squadron 302 (HMHT-302) 'Phoenix' and Marine Heavy Helicopter Squadrons 366 (HMH-366) 'Hammerheads', both based at Marine Corps Air Station New River, North Carolina, will be the first units to operate the CH-53K. *David C Isby*

F-35Bs Arrive in the UK



At 2007hrs local time on June 28, aviation history was made at RAF Fairford when F-35B Lightning II ZM137 (c/n BK-03) landed at the Gloucestershire base; the first F-35 to land on UK soil. Accompanied by two US Marine Corps F-35Bs assigned to Marine Fighter Attack Training Squadron 501 (VMFAT-501) 'Warlords' based at Marine Corps Air Station Beaufort in South Carolina, the three jets arrived in the UK to participate in the Royal International Air Tattoo at Fairford and the Farnborough International Airshow. *Mark Ayton*

Circuit Bashing at RAF Marham



On June 30, UK F-35B ZM137 and US Marine Corps aircraft BuNo 168727/VM19 flew in formation with RAF Tornado GR4 ZG771 over RAF Marham, Norfolk. This was the first flight of an F-35B at Marham, which also included one low and one STOVL approach and fly away. *Mark Ayton*

Then There Were More



Just over 24 hours after the arrival of three F-35Bs at RAF Fairford three more F-35s arrived at Fairford on June 29. Assigned to the 56th Fighter Wing based at Luke Air Force Base, Arizona, F-35A 12-5042/LF touched down on runway 09 at 2025hrs to become the first A-model aircraft to land in the UK. The three F-35As were flown to the UK to participate in the Royal International Air Tattoo at Fairford. *Lockheed Martin*

...and with the Reds



A highlight of this year's Royal International Air Tattoo at RAF Fairford was the daily formation flypast by the Royal Air Force Red Arrows with an F-35B and a Typhoon or two (depending on serviceability). That's showbiz! *Helen Ayton*

Lobos' Special



Força Aerea Portuguesa P-3C Orion-equipped 601 Esquadron based at Base Aerea 11 Beja has applied some colour to the tail of P-3C 14808. The tail markings feature a Wolf's head; the official badge of Esquadron 601 'Lobos' or Wolves. The aircraft is seen during a flight for the Lisbon Air Race on July 3. *Menso van Westrhenen*

Overhauled Hornets

The US Marine Corps announced in June it has received the first two of 30 overhauled F/A-18C Hornets that were taken out of storage at the aerospace maintenance and regeneration facility at Davis-Monthan Air Force Base, Arizona. The overhaul programme started in 2014.

Upgraded to F/A-18C+ configuration during a 12-month depot-level overhaul with Boeing's facility at Cecil Airport, Florida (the former Naval Air Station Cecil Field located west of the city of Jacksonville), each aircraft has its service life extended from 6,000 to 8,000 flight hours.

The upgrade includes an improved version of the Raytheon AN/APG-65 radar, a Link 16-compatible datalink and new avionics, including the Joint Helmet Mounted Combat System (JHMCS). An additional six aircraft are currently being upgraded at Cecil Airport.

The US Marine Corps is facing a decline in the mission-capable rate of its F/A-18 fleet (A+, B, C and D-models). Figures released in April show a rate of 32%, down from 73-77% in FY2009. This year US Marine Corps F/A-18 pilot flight hours have also declined from the objective 15.7 hours per month to 8.8.

Giving testimony before the House Armed Services Committee readiness subcommittee on July 6, Lieutenant General Jon Davis, Deputy Commandant for Aviation said: "We're in a deep hole and have a way to go to climb out." *David C Isby*

Laser-Armed AC-130W

An AC-130W gunship based at Cannon Air Force Base, New Mexico has already been selected to be armed with a high-energy laser (HEL) in place of its side-mounted GAU-23 30mm cannon, according to Lieutenant General Bradley Heithold, commander of Air Force Special Operations Command, speaking at a conference in Washington DC on June 23. Heithold said it will be the first HEL mounted in a manned combat aircraft and his plan is eventually to replace the GAU-23 cannon on "three or four" of AFSOC's AC-130Ws. The HEL will initially use the same broadside mounting as the cannon it replaces. This is intended to minimise the delay and cost of changes to the airframe, even though a ventral turret mount would have a greater field of fire.

The concept of employment for a HEL-armed AC-130W has already been studied by AFSOC; the plan is to develop the HEL to a power rating of 60-120kW by 2020; it will be used for disabling vehicles and communications facilities. Air Force Special Operations Command is seeking some $120 million in funding from Congress to fund HEL integration and testing.

The new Air Force Chief of Staff, General David Goldfein, testified before the Senate Armed Services Committee on June 17 that he was supporting the near-term development of a HEL. He identified the stealth aspects of a HEL's effects as among its strengths: "What we need is a capability to create an effect and not have them know exactly where it came from or who. I think directed energy is going to provide that for us."

Air Force Special Operations Command's HEL programme is being developed in parallel to an effort by the Air Force Research Laboratory and Defence Advanced Research Projects Administration that uses an independently developed 150kW HEL, mounted on a General Atomics MQ-1 Predator unmanned air vehicle. It is currently being tested at White Sands Missile Range New Mexico. The Air Force Research Laboratory and Air Combat Command are working together to develop the Self-defence High Energy Laser Demonstrator (SHIELD), a podded 30kW HEL for integration with onboard systems of fifth-generation fighters to defeat missile threats. Surface-based lasers are also being developed for the counter-UAV mission. The US Army has tested a self-propelled version of the 2kW Boeing Combat Laser Weapons System, mounted on a Stryker armoured vehicle and the Office of Naval Research will test the 30kW Ground Based Air Defence laser in FY2017. The US Navy already has operational 30kW HELs for shipboard anti-missile defence. *David C Isby*

Polish M-346



The first M-346 for the Siły Powietrzne RP (Polish Air Force) (Italian serial number CSX.55209) flew from Venegono airport for the first time on July 4. No Polish national markings were worn. Oscar Bernardi.

Advanced Heavy Lift Rotorcraft Agreement

China's Avicopter and Russian Helicopters have formally agreed to co-operate on the development of a civil Advanced Heavy Lift (AHL) helicopter, according to a June 24 announcement by the Russian manufacturer.

The agreement was signed by Russian and Chinese officials in Beijing in the presence of Russian President Vladimir Putin.

Avicopter, a member of the Aviation Industry Corporation of China (AVIC), will be responsible for management of the AHL programme, including design, construction of the prototype helicopters, test flying, certification and production of the new helicopter. Russian helicopters, a subsidiary of Russia's State-run Rostec organisation, said that it will contribute its technologies to the project. Marketing of the AHL will be undertaken by Avicopter.

Russian Helicopters CEO Alexander Mikheev said: "China is our oldest strategic military and technical partner and we are happy our co-operation has extended to the civil sector. Joint development of the civilian advanced heavy helicopter by our company and Avicopter will not only contribute to the further development of co-operation with the Chinese party in high-tech sectors, but also in the strengthening of friendly ties between Russia and China in general." *Nigel Pittaway*

Kazakhs in Mildenhall



Kazakhstan Air Force C295M 04 seen landing at RAF Mildenhall, Suffolk on July 13. Two other Kazakhstan Air Force aircraft, C295M 03 and An-72 07, also arrived at RAF Mildenhall the same day. The three aircraft transported troops to the UK to participate in the second stage of Steppe Eagle 2016, an annual Kazakh-led international peacekeeping exercise. This year troops from Kazakhstan, Kyrgyzstan, Tajikistan, the UK and the United States participated in stage one, which took place at the Iliysky range in Kazakhstan during April. Stage two was held in the Stanford Training Area and designed to train troops in all aspects of peacekeeping operations, checkpoint activities and manning cargo convoys. Simon Bullimore



Patrol Wings, Presi Helos & Tiltrotor Ta

by Rick Burgess



The US Navy will disestablish its patrol reconnaissance wing in Hawaii next year as it transfers its Hawaii-based patrol squadrons to its wing based at Naval Air Station Whidbey Island, Washington. The action eventually will lead to an end to the permanent presence of patrol squadrons home-based in Hawaii that has endured since the 1930s.

Commander, Patrol and Reconnaissance Wing 2 (CPRW-2), based at Marine Corps Air Station Kaneohe Bay, Hawaii, will be disestablished on May 1, 2017 and its four squadrons will transfer to the control of Commander, Patrol and Reconnaissance Wing 10 (CPRW-10) at Naval Air Station Whidbey Island. The action is driven by the transition of West Coast patrol squadrons from the P-3C Orion to the P-8A Poseidon, which will begin later this year.

Patrol Squadron 4 (VP-4) 'Skinny Dragons', currently on deployment, will transfer to CPRW-10 control on May 10, 2017. It will be the first West Coast patrol squadron to upgrade to the P-8A

Patrol Squadron 9 (VP-9) 'Golden Eagles' and Special Projects Patrol Squadron 2 (VPU-2) will shift to CPRW-10 control on September 1 and May 1, 2017, respectively. A navy directive lists the move of VP-47 'The Golden Swordsmen' to Whidbey Island for April 1, 2017.

The role of Commander, Patrol and Reconnaissance Group Pacific, currently held by CPRW-2 in Hawaii, will also shift to CPRW-10 in Whidbey Island, effective February 1, 2017.

US Navy patrol squadrons were based at Kaneohe Bay and Ford Island on Oahu, Hawaii, before the outbreak of World War Two. After the war, they were consolidated at Naval Air Station Barbers Point and finally moved back to Kaneohe Bay, by then a Marine Corps Air Station as a consequence of a round of base closures.

Helicopter Master Plan Fulfilled

Establishment of Helicopter Maritime Strike Squadron 79 (HSM 79) 'Griffins' marked not only the stand-up of a new squadron but the fulfilment of the US Navy's Helicopter Master Plan. The squadron's establishment was marked in ceremonies held at the squadron's home base at Naval Air Station North Island, part of Naval Base Coronado, California, on June 2. The squadron adopted the nickname 'Griffins' from two former anti-submarine squadrons, SH-60F-equipped Helicopter Anti-Submarine Squadron 9 (HS-9) and S-3B Viking-equipped Sea Control Squadron 39 (VS-39). The new squadron will operate the MH-60R version of the Seahawk helicopter.

The stand-up of HSM-79 marks the completion of a 15-year transition of the US Navy's operational helicopter community under its Helicopter Master Plan. Under the plan, the US Navy retired seven type-model-series — the HH-1N, UH-3H, CH-46D, HH-46D, UH-46D, SH-60B and SH-60F — and replaced them with two types — the MH-60R and MH-60S. Two other older types, the HH-60H and MH-53E, will continue in service.

The master plan also involved transition in the role of two helicopter communities; Helicopter Anti-Submarine Squadrons (HS) and Helicopter Combat Support Squadrons (HC) became Helicopter Sea Combat Squadrons (HSC), and Helicopter Anti-submarine Light Squadrons (HSL) became Helicopter Maritime Strike Squadrons (HSM). The master plan resulted in the establishment of several new squadrons, including HSM-79, to meet the increased demand for helicopters in the fleet.

HSM-79 was originally established on paper on October 1, 2015 and began its training in May 2016. It is scheduled to achieve initial operational capability in January. It will be equipped with 11 MH-60Rs and deploy with a Carrier Air Wing on board aircraft carriers and surface combatant ships.

Presidential Helicopter

The next-generation helicopter to support the President of the United States is scheduled to make its first flight in that configuration in 2017.

Colonel Robert Pridgen, the US Marine Corps' Programme Manager for Presidential Helicopter Programme, spoke during a briefing at the Navy League's Sea-Air-Space Expo at National Harbor, Maryland on May 16. He said: "The VH-92A programme is executing well with all aspects on or ahead of schedule. The key to this is stable requirements, noting there have been no changes since the requirements were set in place."

Col Pridgen attributed the programme's stability to the use of mature technology, including a proven helicopter design and the adaption of an existing mission communications system from the current VH-3D Sea King and VH-60N helicopters. One difference will be the addition of a wideband line-of-sight capability.

According to Spencer Elani, Sikorsky's VH-92 Program Director, the Sikorsky S-92 helicopter will pass its one-millionth flight hour this month. More than 250 S-92s are in service worldwide and the type has its Federal Aviation Agency certification. Once its rotor blades are removed, a VH-92 can be airlifted in a C-17 transport.

The $1.2 billion VH-92A programme completed its Preliminary Design Review in August. Two engineering, manufacturing and development S-92s are currently being modified to VH-92 configuration at the Sikorsky facility.

A Critical Design Review was scheduled for the end of July followed by first flight in 2017. The US Marine Corps is scheduled to take delivery of the first VH-92A in 2018.

A Milestone C decision is expected in 2019 to clear the way for low-rate initial production. Operational Test and Evaluation is set for 2020.

V-22 Tankers

The US Navy's V-22 Osprey programme is working toward fielding an aerial tanking capability for the US Marine Corps' MV-22B tiltrotors by 2018, according to Colonel Daniel Robinson, the V-22 Program Manager with Naval Air Systems Command.

Speaking with reporters on May 16 at the Sea-Air-Space Exposition at National Harbor, Maryland, Col Robinson said the summer of 2018 is the target for aerial tanking capability, which will enable the Aviation Combat Element of a Marine Expeditionary Unit to air refuel F-35B Lightning IIs and CH-53 heavy-lift helicopters, and eventually possibly other V-22s. This capability would extend the reach of Amphibious Ready Groups for strike and assault missions.

dential nkers





Above: ***Marine Medium Tiltrotor Squadron 365 (VMM-365) 'Blue Knights' based at Marine Corps Air Station Cherry Point, North Carolina, has MV-22B BuNo 168305/YM00 painted with a full-colour tail featuring a blue knight. The aircraft is seen at Cherry Point in late April.*** *Nick Martin*

Top: ***Marine Attack Squadron 542 (VMA-542) 'Tigers' based at Marine Corps Air Station Cherry Point, North Carolina, has AV-8B+ BuNo 165354/WH00 painted with a black and yellow tail featuring a tiger's head. The aircraft is seen at Cherry Point in late April.*** *Nick Martin*

Right: ***F/A-18A+ Hornet BuNo 162863/AF11 of Fighter Composite Squadron 12 (VFC-12) 'Fighting Omars' based at Naval Air Station Oceana, Virginia seen at Fallon, Nevada in late-May. VFC-12 deployed to Fallon to bolster the resident adversary force during Carrier Air Wing 8's latest work-up.*** *Nick Martin*



Other future capabilities envisioned for the V-22 include an improved electro-optical/infrared sensor to give better resolution during target acquisition and a reconnaissance and surveillance capability. Greater situational awareness would be available for the marines in the cabin before they arrive at a landing zone, and available to a command element.

The Harvest Hawk roll-on, roll-off strike package (includes AGM-114 Hellfire missiles) currently used by some KC-130J Super Hercules aircraft is being considered by the US Marine Corps' aviation department as is the new Intrepid Tiger electronic warfare system.

Robinson said Naval Air Systems Command is doing some trade studies in weapons: "People are looking at weapons because of the range and speed [of the V-22] for self-escort. The MV-22B is so versatile and flexible, there is a lot of thought being given as to what to put on them."

The US Marine Corps has 253 MV-22Bs in service with 360 aircraft in the programme of record.



F/A-18E Super Hornet BuNo 168910/AJ300 of Strike Fighter Attack Squadron 87 (VFA-87) 'Golden Warriors' based at Naval Air Station Oceana, Virginia seen at Naval Air Station Fallon, Nevada in late-May. The aircraft deployed to Fallon for the latest Carrier Air Wing 8 work-up in this CAG-bird colour scheme. *Dan Stijovich*

Tejas Inducted into Service

The Indian Air Force accepted the first two operational HAL Tejas Mk1 Light Combat Aircraft (LCA) in a ceremony at the Aircraft System Testing Establishment in Bengaluru on July 1.

The aircraft will be operated by 45 Squadron 'The Flying Daggers', initially from Bengaluru, but will later move to Sulur in Tamil Nadu, according to local media reports. The Tejas will broadly replace the ageing Mikoyan Gurevich MiG-21bis in Indian Air Force service.

The air force has an urgent requirement to replace three squadrons of MiG-21s and one flying the MiG-27 that are due to retire this year. The Indian Air Force has experienced a higher than normal attrition rate with its older fighters; the latest crash of a MiG-27 occurred on June 13. All MiG-21 and MiG-27 aircraft are due to leave the Indian Air Force inventory by 2022.

The Indian Air Force hopes to induct a total of six aircraft in the current financial year and a further eight in 2017 against a reported squadron establishment of 20 aircraft. No.45 Squadron is expected to enter the air force order of battle formally in 2017.

The first two jets are part of a batch of 20 initial operational clearance aircraft. These will be followed by 80 more capable Tejas Mk1A aircraft. The interim Mk1A version will address some of the issues found during operational testing of the Mk1 and is planned to be around 1,000kg (454lb) lighter than the earlier version.

India's LCA programme has been running for more than 30 years, and although the air force had reportedly been lukewarm to the interim Mk1A, the service has agreed to field the aircraft after the Israeli Elta EL/M-2052 active electronically scanned array radar, an integrated electronic warfare suite and air refuelling capability was proposed.

Design of the interim Mk1A is due to be completed in 2017, with production beginning in 2019, but the definitive Tejas Mk2 will not be ready for service until at least 2024.

New Radar for MQ-8C Fire Scout

All 40 of the US Navy's Northrop Grumman MQ-8C Fire Scout helicopter UAVs will receive a Selex maritime surveillance radar with 240° coverage and weather detection, air-to-air targeting and moving target indicator capabilities. It will provide cueing for the MQ-8C's turret-mounted electro-optical/infrared sensor and its rangefinder/target designation capabilities. The radar is scheduled to achieve IOC by early FY2020. The MQ-8C, an unmanned version of the Bell 407 helicopter, will undergo operational testing in FY2017. *David C Isby*

Su-30 and Brahmos

BrahMos Aerospace announced it has flown the air-launched version of its supersonic Brahmos cruise missile on an Indian Air Force Sukhoi Su-30MKI for the first time.

According to the company, the 45-minute first flight occurred on June 25 from Hindustan Aeronautics Limited's Ozar facility at Nasik. Initial captive carriage flights will verify the Su-30 and Brahmos combination ahead of the first firing, which is expected to occur later this year.

HAL signed a contract with BrahMos covering modification of two Su-30MKI aircraft to carry the 3,000kg (6,600lb) missile in 2014, which involved significant reinforcement of the basic aircraft's structure. The Indian Air Force plans to modify around 40 Su-30MKI aircraft to carry the missile.

BrahMos said the Su-30 and Brahmos combination will make the Indian Air Force the first in the world to possess an air-launched supersonic cruise missile capability.

HAL's T. Suvarna Raju said: "It is a perfect example of 'make in India' and an engineering marvel in [the] aviation history of India, and proves when all agencies come together with one mission, nothing is impossible."

BrahMos is a joint venture between India and Russia and takes its name from the Brahamaputra and Moskva rivers in the respective countries. *Nigel Pittaway*

The Moose Remembered

Royal Canadian Air Force 419 Squadron has painted CT-155 Hawk 155217 in a commemorative RAF Bomber Command colour scheme to mark its 75th anniversary. The aircraft also wears Lancaster X serial number KB799, a side code W (KB799 was coded VR-W), nose art featuring a black Moose outlined in white on a yellow background (the World War Two squadron motif), and a dedication to its first Officer Commanding Wg Cdr John 'Moose' Fulton DSO DFC AFC.

Lancaster X KB799 'The Moose' was flown by 419 Squadron during World War Two from September 27, 1944, until it was shot down over Germany on January 15, 1945, on a mission to Leuna west of Leipzig. Six of the crew escaped; the pilot, FO Norman Vatne, aged 21, was killed. *Galen Burrows*



Anniversary Challenger



Royal Canadian Air Force 412 Transport Squadron is celebrating its 75th Anniversary this year. Its small fleet of five Challenger CC-144s are wearing commemorative badges on the forward fuselage aft of the main door and on the tail. CC-144C, 144618 (CL604 c/n 5535) is seen at Ottawa MacDonald Cartier International Airport on July 2, 2016.
No.412 Transport Squadron is based in Ottawa, but administratively reports to 8 Wing at CFB Trenton, Ontario. The squadron operates the administrative flight service for high-ranking government officials and foreign dignitaries with VIP air transportation worldwide. Andrew Cline

Dutch NH90 Deliveries Complete

With the arrival of the last two NH90 NATO Frigate Helicopters (NFHs) at Maritime Air Station De Kooy in the first half of this year, all 20 NH90s ordered for the Dutch Defence Helicopter Command (DHC) have now been delivered. The final NH90 NFH built for the DHC, N327 (c/n 1327), arrived at De Kooy on January 20 and commenced operational flying in mid-February, including a six-week deployment on board the Royal Netherlands Navy's air defence and command frigate HNLMS *De Ruyter* as part of the Netherlands Operational Sea Training programme, starting on February 27.

The last helicopter delivered to De Kooy, on June 15, was actually the first one built for the Netherlands (N088, c/n 1088). It first flew on August 9, 2007, but stayed with NH Industries in Italy for the NH90 NFH certification and test flight programme, which concluded last year. The helicopter paid several visits to the Netherlands between 2007 and 2010. Before delivery, it went through the upgrade programme from Meaningful Operational Capable (MOC) to Full Operational Capable (FOC) configuration, including the Final Radar Capability (FRC) modification.

The first seven Dutch NH90s were delivered in MOC configuration in 2010–2012, followed by six FOC-configured examples in 2013–2014. The final seven were built to FOC/FRC standard. The entire fleet will be configured to FOC/FRC standard by 2019. *Kees van der Mark*

Russian Strategic Strike UAVs

Russia has built a prototype of a strategic UAV and is already operating strike UAVs, Deputy Defence Minister Sergei Borisov said on the state-owned Rossiya 24 television news on June 30. He said: "We've seriously caught up in the UAV field and have very competitive types at the tactical, operational and even strategic level – both reconnaissance and strike."

The statement came just weeks after reports that Russia has renewed its development of strike UAVs. These, like the Israeli-designed Harpy, have onboard sensors and an integral warhead. A strike UAV design will be made public for the first time during the Army 2016 international military and technical forum to be held in Moscow on September 6–11. Last year, reports emerged in Russian media that development of a jet-powered strike UAV capable of carrying a 250kg (550lb) payload at a maximum speed of 430kts (800km/h) was nearing completion. *David C. Isby*

Richthofen-zapped Skyhawk



Former Israel Air and Space Force A-4N Skyhawk C-FGZO '532' (BuNo 159534, N266WL), one of six currently flown by Canadian contractor Discovery Air Defence in support of the German armed forces, received a large red 'R' on its tail to mark the official re-establishment of Eurofighter-equipped Taktisches Luftwaffengeschwader 71 'Richthofen' as a full wing on July 1. For the past three years, the Witmundhafen-based 'Richthofen' operated as a group within Nörvenich-based TaktLwG 31 'Boelcke'.
Equipped with a RM-30A1 tow reel and Do-SK6 target, the A-4N is seen at Wittmundhafen on July 4, which has been the Canadian Skyhawks' home base since early 2015. Kees van der Mark

Deli & m

by Nigel Pittaway



The Royal Australian Air Force is now well established in its transition from the Lockheed AP-3C Orion to the Boeing P-8A Poseidon maritime surveillance aircraft, with the first of the new aircraft expected to arrive in Australia in November.

Also arriving in Australia at the end of June were three more Boeing CH-47F Chinooks for the Australian Army and deliveries of both the Airbus Helicopters H135 for the Joint Army/Navy helicopter training organisation and the Lockheed Martin MH-60R Seahawk naval combat helicopter continue.

The Australian Army is to receive a further boost to its intelligence, surveillance and reconnaissance (ISR) capabilities with the recent announcement of palletised surveillance equipment to be installed in some Royal Australian Air Force Beechcraft King Air 350s, to support special forces operations.

AP-3C to P-8A

The first of an initial eight Poseidons for the Royal Australian Air Force (A47-001/N940DS c/n 62288) made its maiden flight on May 6 (see Hawks, Poseidons & Tankers, AIR International, July, p94–95) and is currently undergoing mission systems installation at Boeing's Thompson site in Seattle.

The aircraft will be handed over in mid-November and is expected to arrive at Edinburgh in South Australia, its home-base, by the end of the month. The first squadron to transition to the aircraft will be No.11 Squadron, which is currently one of two AP-3C squadrons at Edinburgh. The other AP-3C unit within 92 Wing at the South Australian base, No.10 Squadron, will also convert to the P-8A at a later date.

Commanding Officer of No.11 Squadron, Wing Commander Nigel Ward, told AIR International that two of the establishment of 12 crews are already undergoing P-8A training with the US Navy's Fleet Replacement Squadron (VP-30) at Naval Air Station Jacksonville in Florida.

He explained: "11 Squadron will hand its remaining Orion operators and aircraft to 10 Squadron at the end of this year, which will grow to the biggest it has ever been. At the end of the year there's going to be an AP-3C squadron and a P-8A squadron at Edinburgh."

The Australian Government announced that it would exercise options on a further four Poseidons with the release of its Defence Integrated Investment Plan (DIIP) in February and forecast the purchase of an additional three, to bring the total to 15 aircraft, sometime in the next decade.

Wg Cdr Ward said: "We look at the AP-3C as our principal warfighting aircraft until comfortably into 2018. The AP-3C will remain the operational platform of 92 Wing until such time as P-8A is declared fully operational, and then the Orion wrap-up process can begin in earnest."

The planned withdrawal date for the AP-3C is in the 2020-2021 timeframe.

More Helicopters

The Australian Defence Organisation's Capability Acquisition and Sustainment Group (CASG) announced on June 24 that a further three CH-47F Chinooks had arrived in Australia on delivery to the Australian Army, two-and-a-half months ahead of schedule.

The three additional aircraft have been acquired under Project Air 4502 Phase 1 (see Airlift & ELINT – Australia's White Paper, AIR International, February, p24-25), in response to a shortfall in Australian Defence Force medium airlift capability, identified by a recent force posture review.

The aircraft were diverted from US Army production and delivered from the production line in Philadelphia to Australia by US Air Force C-17A aircraft. They will join seven CH-47Fs, acquired under an earlier project, at Townsville in north Queensland, with the Army's C Squadron/5 Aviation Regiment.

Major Michael Hansen, executive officer of CASG's Cargo Helicopter Management Unit, commented: "Achieving delivery of three new aircraft inside four months demonstrates a highly effective and co-ordinated project between the US Army, Vice Chief of the Defence Force Group, CASG and Army Aviation.

"By employing the Foreign Military Sales strategy the Australian Defence Force [ADF] also leverages the benefits of being part of a much larger fleet, which is growing to almost 500 CH-47Fs flying with the US Army. Not only does the ADF see the benefits of scale in the initial purchase price, but also the ongoing cost of consumable and repaired items is greatly reduced."

Also in June, the fifth and sixth Airbus Helicopters H135 training helicopters for the Australian Defence Force's Joint Helicopter

veries, Retirement ore ISR



One of the three new Australian Army CH-47F Chinooks delivered to Australia in June being unloaded from a US Air Force C-17A at RAAF Base Townsville. Cpl Mark Doran/ Australian Army

School (N52-005/D-HECO c/n 1217 and N52-006/D-HECP c/n 1218) were noted in flight test at the manufacturer's facility in Donauwörth, outside Munich. Fifteen H135s are being acquired under the Helicopter Aircrew Training System programme, also known as Joint Project 9000 Phase 7. Airbus Helicopters is delivering the aircraft to prime contractor Boeing Defence Australia and the first example (N52-001/ VH-AQG c/n 1179) is already at HMAS Albatross, near Nowra.

An Airbus Helicopters spokesman said that all 15 H135s will have been handed over in Germany by the end of the year. The helicopters are transported to Australia onboard ship, and reassembled and tested at the Airbus Group Australia Pacific facility at Bankstown, west of Sydney, before delivery to Nowra.

Finally, Lockheed Martin was expected to deliver the 24th and final MH-60R to the Royal Australian Navy in July.

ISTAR King Airs

Buried in the Defence Budget Portfolio Statement released by the Australian Government in May, was notification of a AUD $7 million Air Force Minor Project to configure three of the later Royal Australian Air Force No.38 Squadron King Air 350 aircraft with a roll-on/roll-off intelligence, surveillance, target acquisition, reconnaissance and electronic warfare (ISTAREW) mission system, to support the Australian Army's Special Operations Command.

The three aircraft (registered in the A32-6xx block, which are fitted with the later Rockwell Collins Proline 21 avionics suite) will be modified for the ISTAR role by prime contractor Hawker Pacific in the 2016-2017 timeframe.

A Defence spokesperson said. "The initial operating capability milestone is also planned to be achieved within 2016-2017."

The Royal Australian Air Force currently operates two separate fleets of King Air 350 aircraft, leased from Hawker Pacific. Eight aircraft are based with No.32 Squadron at RAAF East Sale in Victoria, to support Royal Australian Air Force Air Combat Officer and Royal Australian Navy Maritime Aviation Warfare Officer training. A further eight are based at Townsville with No.38 Squadron in the light utility transport role.

With the introduction of the Alenia Aermacchi C-27J Spartan, the role of No.38 Squadron is currently under review and the King Air fleet will be consolidated, most likely at East Sale, in the near future.

The Defence spokesperson said: "As part of this review, [the] air force is considering consolidating its King Air fleet at East Sale. A consolidated fleet would result in greater efficiencies in support costs, as well as workforce and training benefits for [the] air force.

"Current leasing arrangements for a number of aircraft [the No.32 Squadron aircraft] are due to be reviewed in 2018, and a decision on the fleet disposition is likely to align with this process.

"[The] air force will continue to support army operations from RAAF Base Townsville, including through the potential use of King Air aircraft."

A350-900's African Debut



Ethiopian Airlines' first A350-900, ET-ATO (msn 40) departing Toulouse on a pre-delivery test flight. *Alexandre Doumenjou/Airbus*

Ethiopian Airlines became the first African operator of the Airbus A350 XWB when it received its maiden aircraft, on lease from AerCap, in Addis Ababa on June 29 as part of its continued expansion plan. To celebrate the delivery of the aircraft, 350 Ethiopian employees gathered in a hangar to form a human image of the A350. The type is being deployed on the carrier's expanding route network, with Lagos and Dubai being the first destinations, followed later by London Heathrow. Flights to Lagos began on July 2. Ethiopian is the seventh operator to receive the type after Qatar Airways, Vietnam Airlines, Cathay Pacific, Finnair, LATAM (formerly TAM) and Singapore Airlines.

Ethiopian ordered 12 A350s directly from Airbus and two on lease from AerCap. A second A350 is expected in August while an A350 flight simulator is being set up at Bole International Airport. Ethiopian's first A350-900, ET-ATO (msn 40), has a two-class layout comprising 30 business class and 313 economy class seats.

The A350 is the first Airbus aircraft in the airline's 70-year history. Ethiopian CEO Tewolde Gebremariam said it was a concern to diversify because different aircraft types add complexity and cost to operations, but the carrier is growing and needs to be competitive. Passenger numbers were up to around seven million in 2015, with the carrier taking advantage of its location to benefit from growing traffic to and from China. The airline's Vision 2025 programme aims to double the fleet by that date, with older aircraft like the Boeing 757 and 767 being retired. Ethiopian said it is weighing up the 366-seat A350-1000 and 777X; 15 to 20 aircraft may be acquired. The carrier has ordered 20 737 MAX 8s, five 787-8s and two 787-9s. Arriving with much less fanfare on July 1 was a Boeing 787-8 Dreamliner. This is one of the early build 787s powered by Rolls Royce Trent 1000-D engines. Another was due in July and a third next year under a sale and lease back agreement with lessor AWAS. *Guy Martin*

Bombardier Water Bombers to Viking

The final Bombardier-built B-415, N385AC (c/n 2095, ex Canadian test registration C-FLFI), for American operator AeroFlite, was the 95th built. *Andrew Cline*



Bombardier Aerospace is to sell its amphibious aircraft programme to Viking Air. The transaction, which is subject to Canadian Government approval, will mean Viking acquires the type certificate and manufacturing rights for the Bombardier B-415 SuperScooper and its variants, as well as the earlier CL-215 and CL-215T.

Bombardier ceased manufacturing operations of the B-415 at its Amphibious Aircraft Division final assembly facility at North Bay Jack Garland Airport, Ontario, at the end of 2015. The North Bay facility was always a low rate production facility, peaking in recent years at four aircraft annually. It was operated under contract by Vortex Aviation, and was closed and cleared out by the end of January. Bombardier's debt issues, largely relating to development delays with the C Series, saw company-wide cuts.

Viking Air, of Victoria, British Colombia, will become responsible for all product support, airworthiness, component manufacturing, parts and service for the family of amphibious aircraft. Viking also acquired the type certificates for the out of production legacy de Havilland Canada fleets from the DHC-1 Chipmunk through the Dash 7 in 2006, and subsequently started building DHC-6 Twin Otters again. It delivered the 100th aircraft new build Series 400 Twin Otter in July.

Viking declined to confirm whether it would restart B-415 production until the acquisition is completed, but will not rule it out if the market bears it. Maintenance and technical support of the B-415 family will see increased staffing of about 40 people between the Viking Calgary and Victoria facilities. A newly acquired and repurposed 50,000ft^2 (4,645m^2) facility acquired in Calgary will partially accommodate the B-415 programme. Viking will take over the responsibility for the worldwide fleet of over 170 water bombers in service with 21 operators in 11 countries around the world. *Andrew Cline*

IN NUMBERS

Airbus

Customer	Aircraft	Number	Date
Aer Lingus	A330-300	2 (exercises existing options)	July 14
AirAsia	A321neo	100	July 12
Air Cote d'Ivoire	A320neo	1	July 11
Air Lease Corporation	A350-900	3	July 11
	A321	1	July 11
ALAFCO	A321neo	10 (conversion of 10 A320neo orders)	July 11
Arkia Israeli Airlines	A330-900neo	4	July 12
AWAS	A320ceo	12	June 23
	A320neo	3	June 23
Cebu Pacific	A320neo	2	Announced June 7, booked May
Germania	A320neo	25	July 12
GoAir	A320neo	72, MOU	July 12
Jetstar Pacific	A320ceo	10, MOU	July 11
Norwegian	A321LR	30 (switch of orders from 30 A320neo MOU signed January 2012)	July 14
Philippine Airlines	A350-900	6 (firms provisional order)	Announced June 7, booked May
Synergy Aerospace	A320neo	62 ((for Avianca)	
Undisclosed	A320neo	45	May 31
	A321neo	15	May 31
Undisclosed	A320neo	8	June 9
	A321neo	7	June 9
Undisclosed	A321ceo	5	June 13
Undisclosed	A320ceo	3	June 30
Virgin Atlantic Airways	A350-900	12	July 11
WOW Air	A321	4	July 12

Boeing

Customer	Aircraft	Number	Date
Air Europa	737 MAX 8	20 (previously unidentified)	July 13
Air Lease Corporation	737 MAX 8	6 (previously unidentified)	July 12
Donghai Airlines	737 MAX 8	25, intent to purchase	July 11
	787-9	5, intent to purchase	July 11
Egyptair	737-800	9 (previously unidentified)	July 13
Kunming Airlines	737 MAX 7	10, MOU	July 12
Okay Airways	737-800	3	June 28
Ruili Airlines	787-9	6	July 13
Standard Chartered Bank	737-800	10 (previously unidentified)	July 11
TUI Travel Group	737 MAX 8	10, finalises purchase agreement	July 12
	787-9	1, finalises purchase agreement	July 12
Unidentified	787	1	June 7
Unidentified Chinese customer	737 MAX/737NG	30	July 12
VIP/business customer	737	1	June 21
Volga Dnepr Group (for Volga Dnepr Airlines and AirBridgeCargo)	747-8F	20 (firms June 17, 2015 MOU)	July 12
Xiamen Airlines	737 MAX 200	30, MOU	July 11

Orders data covers period June 7-July 14, including announcements at the Farnborough International Airshow.
Key: *MOU – Memorandum of Understanding. LOI – Letter of Intent Compiled by Mark Broadbent*

Bombardier

Customer	Aircraft	Number	Date
Air Canada	CS300	45 plus 30 options (firms February 2016 purchase agreement)	June 28
Porter Airlines	Dash 8 Q400	3	July 12
Undisclosed	CRJ900 NextGen	10, purchase agreement	June 20



Bombardier

COMAC

Customer	Aircraft	Number	Date
AVIC Leasing	ARJ21-700	30	July 11
China Aircraft Leasing/Friedmann Pacific	ARJ21-700	60	July 11

Embraer

Customer	Aircraft	Number	Date
Arkia Israeli Airlines	E195-E2	6 LOI, plus 4 purchase rights	July 11
Kalstar	E195-E2	5 plus 5 purchase rights	July 11
Nordic Aviation Capital	E190	4	July 11

Irkut

Customer	Aircraft	Number	Date
Ilyushin Finance (for Azerbaijan Airlines)	MC-21-300	10	June 8

Lockheed Martin

Customer	Aircraft	Number	Date
Bravo Industries	LM-100J Super Hercules	10	July 13

Mitsubishi Aircraft

Customer	Aircraft	Number	Date
Rockton AB	MRJ90	10 plus 10 options, LOI	July 11

RUAG

Customer	Aircraft	Number	Date
New Central Airservice	Do 228NG	1, provisional agreement	July 11

Viking Air

Customer	Aircraft	Number	Date
Longview Asset Management	DHC-6 Series 400Twin Otter	6	July 11
Tara Air	DHC-6 Series 400Twin Otter	3	July 12

Southwest MAX 8s Roll Out



One of the two 737 MAX 8s for Southwest Airlines that emerged from the Renton paint shop in June. *Joe Walker*

Boeing has announced that it will redesign the 737 MAX 7 to increase its seat capacity. The changes to the smallest MAX family variant were announced at the recent Farnborough International Airshow and involves adding up to 12 extra seats to the aircraft, taking its seat count up from the previously planned 126.

Meanwhile, the first two Boeing 737 MAX 8s that will be used in commercial service have emerged from the paint shop at Boeing Field, Renton. The aircraft are for 737 MAX 8 launch operator Southwest Airlines. The jets are currently engineless; their CFM International LEAP-1B turbofans are scheduled to be installed later this year ahead of delivery to the US low-cost carrier.

A Boeing spokeswoman told AIR International: "A small number of production MAXs will roll out without the final engines installed pending flight test completion. This eliminates the additional requirement for long-term engine storage and maintenance on the field. Additionally, any improvements discovered during flight test will be made during change incorporation.

"Some previous durability improvements were identified and will be incorporated into the final production engines delivering later this year. CFM is able to make the changes back at their factory prior to delivery, which is optimal for production flow in Renton."

Boeing has previously spoken of a Q3 2017 delivery of the first MAX 8 to Southwest, but the spokeswoman's statement said: "Flight test is on schedule to meet delivery in the first half of 2017." The four MAX 8 test aircraft have now completed more than 260 flights combined, with recent work including minimum control speeds, ground effects, nacelle cooling and noise. *Mark Broadbent*

ARJ21-700 Finally in Use

The Commercial Aircraft Company of China (COMAC) ARJ21-700 regional airliner has finally entered commercial service with its launch customer, Chengdu Airlines. Ceremonies marking the flights on June 28 were held in Chengdu and Shanghai, where its first passenger-carrying flight began and ended.

The ARJ21-700 is assembled at the COMAC consortium's Shanghai Aircraft Company factory and is configured to carry 78–90 passengers. The aircraft is powered by General Electric GE CF34-10A turbofan engines. It uses Rockwell Collins avionics, and the wing was designed by Ukraine's Antonov.

The ARJ2-700 is significant because it is the first Chinese-built jet airliner built to international standards. It started development in 2002 and was originally scheduled to enter service in 2007, but the first prototype only flew in 2012. The type received its certification from the Civil Aviation Authority of China in late 2014, although it has not yet received US Federal Aviation Administration certification. Chengdu Airlines currently has a further 29 ARJ21-700s on order.

The total order book for the ARJ21-700 now exceeds 400, after COMAC announced two large orders at the Farnborough International Airshow. One order for 60 aircraft came from China Aircraft Leasing, while AVIC Leasing ordered 30 examples. *David C Isby*

The first COMAC ARJ21-700, B-3321 (c/n 106), arriving at Chengdu at the end of its first commercial flight from Shanghai. *Weimeng/AirTeamImages*



Analytics, Apps and 3D

Digitalisation was a big theme at the recent Farnborough International Airshow, where several key industry players announced agreements aimed at harnessing digital technologies to help airlines improve operational efficiencies.

Boeing announced agreements with six airlines to provide a range of real-time analytics services. Delta Air Lines has signed up for Airplane Health Management (AHM) for its 737, 747, 767 and 777 fleets, which will provide real-time analytics-based predictive alerts to reduce delays and cancellations. All Nippon Airways will continue to use AHM tools to monitor its 787s. British Airways has signed up for real-time wind updates software on 88 of its aircraft. GOL will use the Engine Fleet Planning and Costing tool, Pobeda will deploy Fuel Dashboard services for its 737s to improve fuel efficiency, and Yangtze River Express will integrate Toolbox Records to eliminate paper-based maintenance. Separately, Rolls-Royce announced a plan to collaborate with Microsoft to integrate advanced analytics into Rolls-Royce's TotalCare services package. Cloud computing will collect and aggregate engine performance data, while smart analysis capabilities and predictive tools will assist airlines in reducing fuel burn, flying more efficiently and service engines more quickly.

GE Aviation, meanwhile, announced a new digital solution built on its Predix cloud-based app that uses real-time operational data about network operations, mobile pilots and flight phases. Flydubai has begun using the app across its 737 fleet. GE has opened two data analysis centres in Dubai and Paris to help implement the platform; a third centre in Austin is due to open in the autumn. GE also announced an Engine Health Validator app to help customers evaluate and predict engine condition.

Another notable headline in the digital area was Airbus announcing the use of a mini UAV equipped with a HD camera to conduct aircraft inspections. The data generated from the flights is compiled in a 3D digital model and analysed to help engineers trace and resolve damaged areas on a fuselage more quickly than a manual check, minimising aircraft downtime. A full-scale industrial test is being conducted on in-house A330s. Airbus intends to implement the technology on other programmes. *Mark Broadbent*

IN NUMBERS

71

HOUR SOLAR IMPULSE ATLANTIC CROSSING

Solar Impulse 2 (HB-SIB) became the first solar-powered aircraft to cross the Atlantic Ocean after completing a 71-hour, eight-minute flight from New York JFK to Seville, Spain in the latest leg of its attempt to become the first solar-powered aircraft to circumnavigate the globe. The aircraft later flew to Cairo as it prepares to return to its Abu Dhabi starting point. *Mark Broadbent*

100

SERIES 400 TWIN OTTERS PRODUCED

Viking Air's 100th production Series 400 Twin Otter (c/n 944) has flown from the company's production facilities in Canada. The aircraft will be delivered to Viking sister company Pacific Sky Aviation and will be used as a factory demonstrator. Viking Air launched the Series 400 Twin Otter in 2007 after purchasing the Type Certificates for legacy de Havilland aircraft the previous year; the type first flew in 2010. Series 400s have now been delivered to more than 30 customers. *Mark Broadbent*

12

A350-1000s FOR VIRGIN ATLANTIC

Virgin Atlantic Airways has purchased 12 A350-1000s, nine directly from Airbus and three from a lessor, as it continues its fleet recapitalisation process. The aircraft, which will be delivered from 2019, will replace Virgin's remaining 747-400s and A340-600s. They will operate both business and leisure routes, initially serving destinations in the US, and will be delivered in two configurations: one for the business fleet with 360 seats, the other for the leisure fleet with up to 410 seats. *Mark Broadbent*

33,000

NEW AIRLINERS PREDICTED BY AIRBUS

The recent Farnborough International Airshow saw both Airbus and Boeing issue optimistic forecasts about new aircraft demand over the long term, despite some current economic uncertainties. Airbus' Global Market Forecast predicts there will be a need for over 33,000 new aircraft over the next 20 years (comprising 32,425 passenger aircraft and 645 freighters). Boeing's Current Market Outlook forecasts a need for 39,620 new airliners, including 28,140 single-aisles and 9,100 widebodies. Both companies believe Asia will lead the way. Boeing predicts a need for 15,130 new aircraft there; Airbus believes that region will account for 39% of new single-aisle and 46% of new widebody deliveries in the next two decades. *Mark Broadbent*

20

747-8Fs FOR VOLGA-DNEPR

Volga-Dnepr Group gave the Boeing 747 programmme a boost in July by placing a firm order for 20 747-8Fs. The Jumbos will complement the Group's existing 747-8Fs and replace its ageing 747-400s. The order was the largest single commitment for the 747-8 since 2009. *Mark Broadbent*

IN BRIEF

MRJ Testing Update

The two Mitsubishi Regional Jet (MRJ) flight test aircraft have expanded the regional jet's flight envelope to Mach 0.78 and 39,000ft (11,887m). Instrument flying in poor visibility, one engine inoperative, stalling, and assessments of the terrain awareness and warning system and traffic alert and collision avoidance system have also been completed. Fuselage parts for the first series production MRJ that will be delivered to launch operator All Nippon Airways have arrived at the Mitsubishi Heavy Industries Tobishima Plant ahead of subassembly. *Mark Broadbent*

Siberian Il-76 Disaster

A Russian Ministry of Emergency Situations Ilyushin Il-76 Candid with a crew of ten aboard was lost while flying a fire-fighting mission in the Bayandayevsky district near Lake Baikal in Siberia on June 30. The wreckage was not located until July 3. Eight Il-76s (five water bombers and three transports) and two Beriev Be-200 amphibians had been among the aircraft fighting a fire in the area. The Il-76 had been configured as a water bomber, carrying up to 42,000 litres of water. *David C Isby*

Ghana Seeks New National Carrier

Ghana is seeking international partners to establish a new national airline. Ghana's Ministry of Transport said an experienced partner with a global distribution network was needed to take advantage of market opportunities. Chief Director of the Ministry of Transport Twumasi Ankrah Selby said he hoped to find a partner by the end of 2016. Kenya Airways, Qatar Airlines and Ethiopian Airlines have expressed interest in setting up the new carrier. Ghana hopes to establish Kotoka International Airport as a hub in West Africa. *Guy Martin*

Ruslan Upgrade

The Antonov An-124-100 Ruslans of Antonov Airlines are to receive upgrades to their D-18 engines following an agreement between Ivchenko-Progress and Motor Sich. The modernisation, from series 3 to series 3M standard, will reduce noise and emissions and increase service life by 2,000 flight hours to 14,000 flight hours. The upgrade work will begin next year. Antonov Airlines currently operates seven An-124-100s. *Mark Broadbent*



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David Armstrong reports on a time of expansion and confidence at All Nippon Airways

When All Nippon Airways (ANA) flight NH 1977 from Los Angeles to London touched down at Heathrow last December and 'Star Wars: The Force Awakens' stars Harrison Ford, Daisy Ridley and John Boyega got off the plane, it was clear this was no ordinary flight. Its exterior painted with Star Wars references, the aircraft didn't come from a galaxy far, far away; but it did signal the far-reaching ambitions on Planet Earth of its operator, ANA, a Japanese carrier coming into its own through an audacious combination of colourful marketing, fine-grained cabin service and fast-growing international service.

The aircraft in question, one of three ANA jetliners adorned with Star Wars livery, was a Boeing 787-9, JA873A (c/n 34530), underscoring ANA's status as launch customer for the Dreamliner. Since flying its first 787 in November 2011 – painted in

A Force Awakens



Boeing 787-9 JA873A (c/n 34530) is one of three ANA aircraft to sport a special Star Wars livery. *Matthieu Douhaire/AirTeamImages*



1

1 Business class, seen here with the Dreamliner's mood lighting, is equipped with 44 seats. *Rudi Boigelot/AirTeamImages* **2** ANA subsidiary Vanilla Air uses eight aircraft, including A320-214 JA07VA (msn 6422), on routes between Hong Kong, Taiwan and Japan. *Felix Gottwald/AirTeamImages*

the airline's traditional blue and white livery – ANA has come to operate the world's largest fleet of 787s. To ANA, the stylish, fuel-sipping aircraft is an engaging example of green efficiencies, technological innovation and futuristic design.

After striking a five-year deal with the Walt Disney Company (Japan) Ltd to display imagery from Star Wars, ANA used the deal to promote its own expansive agenda. In a statement, the airline declared: "Through the Star Wars project, ANA hopes to further its international presence. With demand increasing for flights to Japan and Asia, ANA is committed to linking global markets and offering the best possible flight experience through innovative partnerships and branding opportunities."

Growing Presence

It's a lofty goal for an airline that spent much of its 64-year history as a steady, successful carrier in the Japanese domestic market yet little-known outside Japan until the dawn of the 21st century. Founded in 1952 and always privately run, ANA was overshadowed by government-owned Japan Airlines (JAL), the long-time national flag carrier.

That began to change when JAL flew into bankruptcy protection from January 2010 to September 2012. While initial media reports claiming that JAL would shed most if not all of its international network proved to be wrong, ANA used JAL's reversal of fortune to expand its own network and suite of services. It is now Japan's largest airline by fleet size, revenue and international traffic. In fiscal year 2015, ANA carried 50.8 million passengers, its record-high, and 16.1% were international travellers.

The burgeoning Asia-Pacific aviation market and the global surge in profits for major carriers have also benefited ANA. In its 2015 fiscal year, parent company ANA Holdings reaped record-high group net profit of $723 million, up 99.2% from fiscal year 2014. Its consolidated operating profit grew by 49.1%. Sales were up 4.5%.

Much of the growth is down to robust recent expansion of its international service, which began in 1986 with a fledgling flight from Tokyo to the Pacific resort isle of Guam. Thirty years later, ANA operates 81 international routes, using both Tokyo Haneda International Airport and Tokyo Narita International Airport. ANA also flies 112 domestic routes in Japan.

In the second half of 2015, ANA launched four new international routes, most of which are thriving. In an email to AIR International, Hideki Kunugi, ANA's senior vice president, the Americas, put the load factor on ANA's new service between Tokyo and Houston at 80%. Service between Tokyo and Kuala Lumpur is running at 88%, he said. Flights between Tokyo and Sydney are packed to 90% capacity. Tokyo-Brussels, launched last October, trails with a 60% load factor, which Kunugi says is due to the terrorist attacks in Paris in November 2015 and Brussels in March 2016.

Vanilla Air

Closer to home, ANA has jumped into the low-cost carrier (LCC) scrum, most notably with its wholly owned subsidiary Vanilla Air, founded in 2013 and based at Tokyo Narita. With a fleet of eight aircraft, Vanilla Air flies to eight destinations in Hong Kong, Taiwan and Japan. While four-class international service is ANA's primary focus, its LCC flights, with low fares but high levels of service that Japanese customers expect, are part of ANA's plans for continued growth. Traditionally, Japanese air passengers have regarded budget airlines with scepticism, fearing safety and service fall well below the standards of legacy network carriers. ANA is trying to change that.

Kunugi explains: "Vanilla Air, with Narita Airport as its hub, is 100% funded and managed by ANA. It is our goal to increase market share in Japan, where the [LCC] number is fairly low [9%], and cultivate new demand. Vanilla's financial performance improved largely during the first half of the fiscal year 2015 [April to September] and we are expecting to see a profit at the end of the year. In the fiscal year 2016, the ANA Group is planning to expand Vanilla's operational capacity and target Asia, where Japan inbound demand continues to grow, and the resort markets untapped by ANA."

All told, ANA has 35,000 employees, operates a fleet of 258 aircraft, including 42 Boeing 767-300s, 32 Boeing 787-8s and 28 Boeing 777-200s. Japan Airlines remains ANA's chief competitor. Others include Delta Air Lines, Cathay Pacific Airways, Korean Airlines and Air China in its home region, and Middle East giants Emirates Airline, Etihad Airways and Qatar

Airways, which contest Asia-Europe routes. ANA operates code-shares with Lufthansa Airlines, Singapore Airlines, Turkish Airlines and Etihad, among others, many of them Star Alliance member airlines; ANA joined Star in 1999. ANA is especially close to fellow Star member United Airlines, with which it has an antitrust immunised transpacific joint venture. That collaboration allows customers to connect and continue journeys to ANA's 11 city markets in China and United's many North American markets.

Increased Tourism

The Star Wars joint promotion cited earlier is not the first time ANA has linked itself to a global pop-culture phenomenon. In the late 1990s, the airline painted the exterior of several planes in the bright colours of Pokémon, the made-in-Japan video game and media franchise. However, Kunugi says Star Wars has taken ANA's pop-culture marketing to a new level: "It has been overwhelmingly positive throughout the world. We are greatly honoured and gratified to be associated with such a prominent brand."

Even so, 'The Force Awakens' is far from the only high-powered marketing tool in ANA's kit, and by no means the most important one. That would be the high-profile tie-in with the 2020 Tokyo Olympics and Paralympic Games, for which ANA is the official partner airline. ANA is sponsoring a Japanese wheelchair-tennis player, operating a website with profiles of prominent athletes and sponsoring television commercials featuring Olympic gold medal sprinter Usain Bolt.

Driven by the gravitational pull of the Games and, importantly, newly relaxed Japanese visa restrictions for travellers from East Asian nations, international arrivals to Japan are spiking. Tourism from mainland China, South Korea and Taiwan is especially strong. In 2015, Japan surpassed its previous full-year record of 13.4 million foreign tourists by reaching 19.7 million.

In December 2015, Shinya Katanozaka, president of ANA's parent company ANA Holdings, told the Nikkei Asian Review: "Foreign tourists are attracted to the Japanese brand, which covers a wide array of categories such as the beautiful scenery, food, culture and electrical appliances, and they come here to experience it. They then report their experiences overseas via social networking services, which brings in more travellers and gives rise to a virtuous circle."

Indeed, the future looks bright from the curving blue-glass tower that houses ANA's corporate headquarters in Tokyo's Shiodome City Center. The once-sleepy carrier is wide awake, eyes intently focused on the future. However, some aviation industry analysts say some of ANA's decisions are not as uncomplicated or stress free as they appear.

New Aircraft

In an analysis dated January 10, Sydney-based consultancy the CAPA Centre for Aviation noted ANA's sharp turning away from an oft-stated position on A380s: namely, that it wasn't interested in buying any. That changed in late 2015, when ANA agreed to purchase three A380s, with delivery from 2018, for use on its Tokyo-Honolulu route, popular with Japanese leisure travellers who see Hawaii as a prime holiday and wedding destination.

ANA isn't speaking publicly about its change of heart, but CAPA thinks it knows why it happened. When, in 2015, Japanese low-cost carrier Skymark, carrying heavy debt from orders for A380s, went into bankruptcy protection, Airbus had a lot to say about what came next.

CAPA's view: "ANA won the last-minute support of Airbus to vote for its restructuring plan for bankrupt Skymark Airlines . . . over the alternative restructuring plan proposed

2





by Delta . . . In exchange for Airbus's support, ANA agreed to do more business with Airbus." ANA bought a 16.5% stake in extensively restructured Skymark, Japan's third-largest carrier.

According to CAPA: "The attraction was not just Skymark's licence, but also its 36 daily slot pairs (third-largest after ANA and JAL) at the restricted airport Tokyo Henada." That had the knock-on effect of limiting the Japanese footprint of US carrier Delta, a formidable competitor with designs on the aviation market in the Land of the Rising Sun.

For its part, ANA hasn't said why it changed its mind about buying A380s. Kunugi said: "We refrain from commenting on this matter for the time being."

However, AIR International asked Kunugi in an email interview whether ANA's A380 order signals a move away from Boeing towards Airbus, or if ANA's historic relationship with Boeing is still strong. He replied: "We choose aircraft not by the manufacturer, but by: 1. aircraft quality; 2. financial impact; 3. timing of the purchase."

Like many airlines, ANA has experienced hiccups on new aircraft orders. The 787 was delayed for years before ANA flew the first examples in late 2011. In January 2013, ANA, like all other 787 operators, grounded its fleet until April of that year due to concerns about the 787's Lithium-Ion batteries, when national regulators gave the go-ahead to resume flying the next-generation composite aircraft.

This was not the only turbulence to batter ANA's fleet-renewal schemes. Last December, Mitsubishi Aircraft announced that the timetable for rolling out its new Mitsubishi Regional Jet would be delayed for the fourth time – a delay the Nikkei Asian Review attributed to "safety checks and specification changes" taking longer than expected. Nikkei Asian Review speculated that unidentified "specification changes requested by ANA are another likely factor behind the delay". Mitsubishi's regional jet production schedule is running five years behind on the timeline first mooted in 2008, with deliveries now expected to begin in 2018. ANA has ordered 25 of the aircraft.

ANA is diplomatic in addressing the delays, and what, if any, financial compensation it may demand from Mitsubishi Aircraft. "We are disappointed about the delay," Kunugi acknowledged, "but our priority is to have the aircraft delivered in the most reliable shape. Once we have an accurate picture of the updated delivery schedule, we will assess the impact and plan to minimise it by reorganising our regional jet operation/network and fleet planning. We refrain from discussing compensation from contractual obligations."

In Flight

Matters under ANA's direct control are moving more smoothly. The airline has won praise for its in-flight service on long-haul international flights, especially at the front of the aircraft in first class and business. ANA international cabin crews are notably more fluent in English than they were just a few years ago. ANA's premium food, in-flight entertainment systems and fully flat-bed seats are well-regarded by frequent flyers. While ANA has joined other airlines in packing more seats into economy class, with some aircraft having rows ten seats across (up from nine), high-yield passengers are not affected.

ANA diversified its in-flight cuisine by introducing its promotion Tastes of Japan by ANA in 2013, to familiarise travellers with distinctive regional specialties of Japan. It has not forgotten liquid favourites, either, establishing Japanese Sake Corners where customers can sip Japanese rice wine and shochu spirits in ANA lounges in Tokyo Henada, Tokyo Narita and Osaka Kansai airports.

From March through to May 2016, for example, first class passengers could sample Oirase garlic pork, a flavoured pork from Aomori prefecture produced from animals fattened on a garlic diet. In business class, the airline served seerfish, a Japanese white fish, and a variety of mackerel caught in Saga prefecture and accompanied by ten-grain rice miso. By the time the Tastes of Japan promotion runs its course, ANA expects to serve food and drink from all of Japan's 47 prefectures.

ANA's grace notes in the air and on the ground have not gone unnoticed. In March, Skytrax, the UK-based aviation consultancy and research company, awarded ANA its highest five-star rating, one of seven global airlines so cited. It is the fourth consecutive year ANA has had a five-star Skytrax quality rating.

Back on the ground, ANA says it is combatting stiff competition from high-speed rail – Japan's famed Shinkansen bullet trains – by showcasing ever-posher airport lounges, offering discounted fares, quicker airport check-in and security clearance as late as 15 minutes before boarding. The airline also uses its frequent flyer programme, ANA Mileage Club, with some 26 million members, to woo travellers.

In January, ANA Holdings rolled out its goals for fiscal year 2020. While holding domestic seat capacity and revenues steady, ANA hopes to: increase international seating capacity by half in 2020; expand its fleet to 300 aircraft from 250; triple revenues from Vanilla Air and its LCC division; increase



1 Boeing 777-200ER JA744A (c/n 40903), photographed at Sapporo, is one of 28 Triple Sevens in the ANA fleet, that according to the aircraft's latest schedules are used on intra-Asia routes. *Edwin Chai/AirTeamImages* **2** ANA was the launch operator of the 787, and by late April had 46 examples (35 787-8s and 11 787-9s) in service. Here JA837A is pictured at Paris Charles de Gaulle. *Paul Marais-Hayer/AirTeamImages*

international passenger and cargo revenues by 40%; and earn an operating profit of JPY 200 billion.

In a statement, ANA said the multifaceted scheme, "takes into account a range of factors, including cost-benefits from falling fuel prices, the growth in in-bound tourism to Japan, the planned increase in landing [slots] and take-off slots in the Tokyo area in line with the Tokyo 2020 Olympic and Paralympic Games and continued economic growth in regions such as Asia. Set against this, ANA has also factored-in concerns surrounding the slowdown in the economies of China and other emerging countries and stagnation in the resources sector."

At the heart of all this commercial churn is ANA's ambitious international service that began so modestly 30 years ago to Guam. This year, ANA plans to inaugurate service to Wuhan, a central China metropolis of eight million people, and to Phnom Penh, the capital city of Cambodia.

Kunugi concluded: "The international operation will play the most pivotal role in growth, and we strategise to expand the operation mainly in Asia. This trend will continue to drive ANA's business development."



Riccardo Niccoli profiles the Swiss turboprop – and gains a first-hand experience flying in it



The Pilatus PC-21 is different from other turboprop trainers in its performance and its advanced training system capabilities. Can the PC-21 be considered an evolution of the PC-9? Absolutely not: it is a completely new design, conceived to produce a new generation training system to train student pilots not only in the basic phase of their syllabus, but in the advanced and lead-in fighter training (LIFT) phases.

Many years ago, an expert aviation engineer told me: "If you want to understand an aircraft, to know what it has been designed for, to catch its soul, just look at the wing." Let's have a look at the PC-9 wing. It is straight, thick, with a span of 10.12m (33ft 3in), an area of 16.3m^2 (175.5ft^2) an aspect ratio of 6.3, and with a maximum take-off weight (MTOW) typical wing load of 138.1kg/m^2 (28.3lb/ft^2). In contrast, the PC-21 wing is 13° swept, with winglets, has a laminar airfoil, a span of 9.10m (29ft 11in), an area of 14.9m^2 (160.4ft^2), an aspect ratio of 5.1, and the MTOW aerobatic wing load is 208kg/m^2 (42.6lb/ft^2).

The comparisons show how the PC-21 was designed to be faster and more agile than the PC-9. You can also see this by comparing the engine power of the two aircraft: 950shp (708kW) for the PC-9, a staggering 1,600shp (1,193kW) for the PC-21. Finally, the PC-21 has a very sleek and aerodynamic layout that gives you an idea of speed even on the ground. It is not a traditional, straight-wing trainer. Pilatus's idea was to create a turboprop that had all the advantages of a light turboprop aircraft coupled with handling, performance and the feeling of a jet trainer.

Did they succeed? AIR International was given the opportunity to find out during a two-day immersion in the PC-21 environment at Pilatus's home plant at Stans.

Project Pillars

We were given briefings on the PC-21 training system, the aircraft equipment and avionics from Raimund Sauer (a former Luftwaffe F-4 pilot, now Pilatus Regional Sales Director) and Martin Mendel (a former Luftwaffe Tornado pilot and T-6 instructor at Sheppard Air Force Base, today Pilatus's Production Test Pilot and Flight Instructor).

The PC-21 was launched in November 1998, and the first prototype (HB-HZA) flew for the first time on July 1, 2002. The launch customer was the Republic of Singapore Air



More than 180 PC-21s have been ordered by air forces in Singapore, Switzerland, the UAE, Saudi Arabia, Qatar and Australia.
All photos Pilatus unless stated

Force, which received the first of 19 units in April 2008, followed by the Schweizer Luftwaffe, which received six in April 2008 and two more in 2012. Since then, the UAE Air Force has ordered 25, the Royal Saudi Air Force 55, the Qatar Emiri Air Force 24, the Royal Australian Air Force 49 and the Royal Jordanian Air Force eight. At the time



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of writing, the PC-21 order book consisted of 188 aircraft.

The reasons for this success can be easily identified in the quality of the Swiss factory's products and support (three of these five air forces were already Pilatus customers), but also in the philosophy at the heart of the aircraft. There are three pillars sustaining the PC-21: its performance, its low costs and the full training system that comes with the aircraft.

The wing and aerodynamics, coupled with the 1,600shp Pratt & Whitney Canada PT6A-68B turbine and a 92in (2.337m) Hartzell five-blade graphite/titanium propeller, is able to launch the aircraft to a 337kts (624km/h) maximum cruising speed at 10,000ft (3,048m), and allow a maximum climb rate (sea level) of 4,250ft/min (1,295m/min).

What is really interesting is that such performance can be attained with a purchase price that Pilatus claims is about 25% that of a LIFT jet, with a 50% less direct operating cost to the nearest jet-powered competitor.

The key to reducing training costs today is the ability to download training activity from advanced training units to the basic and advanced phases, using modern and efficient aircraft, well-integrated into a ground-based simulation system and an embedded in-flight simulation system. These capabilities are necessary because the fighter pilots of today and tomorrow are now dedicated to managing their weapons systems as well as purely flying their aircraft, and the longest part of pilots' training today is getting them used to managing all the various modes and capabilities of their 'flying computers'. The PC-21 can be used by pilots to perform the basic, advanced and LIFT phases, as well as by navigators and weapons system operators.

The Aircraft

The PC-21, with its 3,100kg (6,834lb) MTOW in aerobatic configuration, is a light aircraft. We've already introduced its wing, which houses the fuel tanks (about 1,200lb/544kg in total) and is equipped with flaps and spoilers (the latter increase the roll rate). The damage-tolerant airframe has been designed for +8/-4 g loads (aerobatic), or for +5/-2.5g at the maximum utility weight (4,250kg/9,370lb), and has a demonstrated, conservative life limit of 15,000 flight hours, based on a fighter aircraft-derived design spectrum (the full scale fatigue test airframe completed 45,000 simulated flight hours). Other interesting features include the stepped cockpit, with a front canopy that can resist birdstrikes at high cruise speeds, the pressurised cabin equipped with an anti-g system and two Martin-Baker Mk-CH16C zero/zero ejection seats. There is an onboard oxygen generation system, a health and usage monitoring system, anti-skid brakes and a pressure refuelling system.

The scheduled maintenance is set only at 150 and 300 hours, and there is no need for depot overhauls. Every part and system on the PC-21 is easily accessible thanks to large service panels, including one on the bottom fuselage that allows the mechanic to stand inside the avionics bay. An advanced support equipment package includes integrated electronic technical publications. A fast turnaround can be carried out by a single mechanic in just 12 minutes.

The Cockpit

But the heart of the PC-21 is its glass cockpit, and its embedded simulation capability. The front cockpit is dominated by three large (150 x 200mm/6 x 8in) night vision goggles (NVG)-compatible active matrix liquid crystal multifunction displays (MFDs), and by a head-up display (HUD). The rear cockpit is pretty much the same, with the exception of the HUD, which is replaced by a HUD repeater.

The layout is quite similar to those of the Typhoon, Rafale, or Gripen: Pilatus can customise the avionics symbology according to the customer's needs. The MFDs can display a wide variety of pages. Usually, the primary flight display (PFD, showing all the flight instruments) is selected in the middle, while the moving map display, navigation and tactical display or synthetic radar display can be shown on the left. On the right is the weapons configuration page (simulated), and the engine and fuel data display. For basic training, the two lateral MFDs can be turned off and only the middle PFD left on for the student, while the instructor in the back seat can use all three MFDs to maximise situational awareness.

These systems are all controlled by the Open System Mission Computer (OSMC). Above the two lateral MFDs, there are other instruments, a secondary flight display and an engine monitoring display (these are not driven by the OSMC, and provide a back-up in case of failure of the main systems). Above the PFD is the up-front control panel, which allows control of the navigation and communication systems, as well as the weapons delivery.

The navigation/communications suite



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1 A 1,600shp Pratt & Whitney Canada PT6A-68B turbine and a 92in (2.337m) Hartzell five-blade graphite/titanium propeller helps give the PC-21 considerably better performance than earlier Pilatus trainers. **2** The PC-21 wing, 13° swept and with winglets, has a laminar airfoil, a span of 9.10m, an area of 14.9m² and an aspect ratio of 5.1.



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can be tailored to the customer's needs, but as the PC-21 has civil as well as military certification, it has a complete equipment fit-out, including VHF/UHF radios, emergency locator transmitter, automatic dependent surveillance-broadcast receiver, inertial reference system integrated with a GPS, digital air data computer, two VOR/ILS, distance measuring equipment sets, a radar altimeter and a flight management system. Other systems can be integrated, such as a tactical air navigation system, and an autopilot and flight director system.

Flight controls comprise a stick in the middle, and a throttle (called a Power Control Lever) on the left side flanked by the flap selector. The controls follow the hands-on throttle and stick philosophy, and include

AIRBORNE IN THE PC-21

I was given the opportunity to try the PC-21 Flight Training Device for a good hour to familiarise myself with the cockpit, its controls and the aircraft's flight performance. While I did this, Production Test Pilot and Flight Instructor Martin Mendel allowed me to perform some standard manoeuvres, while he demonstrated the embedded simulation in air-to-air and air-to-ground modes. Even if a flight simulator is never capable of exactly rendering a real flight, I can appreciate that at low speeds the PC-21 remains an easy aircraft to fly. An approach can be set at about 105-110kts (194-204km/h), and the final, flare and touchdown phases can be managed by the pilot as in a normal turboprop or propeller trainer of far lower performance and power. Before the end of day one, we make a further stop, at the life support area of the Pilatus Flight Department, where all the flying equipment is professionally tried and checked, under the careful eye of Guido Frey. He explains the features of the survival pack included in the life vest, and the ejection seat.

Day two starts at 08:00hrs with the briefing for the first flight. The weather is a bit tricky, with fog that should partly disappear during the morning, allowing us to take-off and find a hole to climb well over the Alpine tops. This will be a single-ship mission to show me the PC-21's flight qualities and navigation and embedded simulation in the air-to-ground mode. We step out to our aircraft, the third PC-21 built (HB-HZC, c/n 101), which stands on the ramp in its smashing red livery.

The position in the rear cockpit is quite comfortable, and thanks to the stepped tandem seats, the visibility is excellent. Once all the usual procedures to secure oneself to the seat and to the survival systems (belts, leg restraints, survival pack, anti-g, oxygen mask and radio jack plugs) are completed, it's time to close the canopy. Martin reminds me to lower my helmet's visor. The PC-21's front canopy features a miniature detonating cord that will shatter it in the event of an ejection. This system is necessary because the front part of the canopy is built to resist high-speed birdstrikes, and cannot be safely broken by the ejection seat alone. The start-up procedure is quite simple and quick. Power on, then push the start button and, above 13% Ng (the RPM) move the throttle to idle position.

We taxi to take-off from runway 25, and while Martin checks the instruments and the brakes, I take note that atmospheric pressure is 1018, the outside temperature is 7°C, elevation is 1,450ft, and there is 1,190lb (540kg) fuel on board, which gives us a total take-off weight of about 3,050kg (6,718lb). The tower clears us to cross a road (one of the special features here at Buochs and Swiss military bases) and move to the runway, while on the right a grandmother with three children cheer us on.

Lined-up on the 6,600ft (2,000m) runway, and cleared by the tower, we gently wind up the engine and release the brakes. The thrust is strong, but easily controllable, thanks to some special features designed by Pilatus to make the PC-21 handling similar to that of a jet. From zero to 80kts (0-148km/h), the Power Management System (PMS) delivers 1,080shp. To compensate for the big torque forces, the engine is installed with a 2° angle to the right of the centreline, and the tail features an auto yaw compensation called TAD (Trim Aid Device). To keep the centreline during the take-off run requires only a few touches of the right pedal, and at 92kts (170km/h), after some 13 seconds, we gently pull the stick and we are in the air. Gear and take-off flaps up over 120kts (222km/h) and the PC-21 rapidly gains speed. We stay below the fog and turn right, heading to the south end of Lake Lucerne, where the fog is starting to dissipate. Above 200kts (370km/h), our engine delivers all its 1,600shp, and with even less than 100% torque, we easily reach a cruise speed of 270kts (500km/h), with a fuel flow of 840lb/hour. The feeling is different from other propeller aircraft, as we fly smoothly and quietly, without noise or vibrations.

The first part of our flight is a navigation run around some of the most beautiful mountains in the Alps. At the end of the lake, we zoom over the fog, and heading west, we start a navigation that brings us over Engelberg, near the Titlis peak (10,627ft/3,239m), then we break right over the Gadmental valley, passing close to the Wetterhorn and right past the Eiger's north face. At this altitude, with a 100% power setting, our fuel flow is about 750lb/hour. We turn south, crossing over the Jungfraujoch (11,468ft/3,475m) and then over the Aletsch Glacier, the biggest glacier in the Alps. Turning east we pass south of the Fiescherhorn, to dive at 300kts (555km/h) down in the 'S' canyon of the Unterer Grindelwald Glacier, an exciting experience that, with strong southerly tail winds, shows the aircraft's good handling and stability, thanks to the relatively high wing load. The navigation systems, displayed on the left MFD, give a very clear representation of the ground map and of all the waypoints, and the other necessary information.

Now it's time to head back to Buochs, to fly in the airspace box (LSZC CTR) located above the Lake Lucerne, to assess some basic manoeuvres. At around 10,000ft we try stalls and spins, first demonstrated by Martin, and then I have a go. Both these manoeuvres seem very simple, and develop in a textbook way: the stall in clean configuration occurs at about 90kts (166km/h), and is completely honest, while the spin is a bit less conventional (you enter with a roll, and you can feel the moderate swept wing) and is slightly harsher.

We perform four stable spins, losing some 500ft per turn, but the recovery is very simple, and follows the rules valid for all straight-wing propeller aircraft: to stop the spin, reduce power to idle, apply opposite rudder and centre the stick. We then move on to some basic aerobatics.

The loop can be started at any speed above 200kts (370km/h), but let's say that 250kts is more comfortable. Pulling some 3.5 to 4 g, and with a limited use of the rudder, only on top of the loop, this manoeuvre can be easily performed even by a pilot of a limited experience like me. The roll is another textbook manoeuvre, but allows me to experience the very high roll rate of the PC-21: a good 200°/sec. This performance is made possible by the roll spoilers located on the wing, which operate in conjunction with the normal, but hydraulically-boosted, ailerons. Generally speaking, the feeling is quite



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1 The PC-21 Integrated Training System features training documents, computer-based training and synthetic training devices (pictured) that take students up to the first flight and assist them in getting used to managing different modes and capabilities. *Riccardo Niccoli* **2** Two of the eight PC-21s operated by the Schweizer Luftwaffe, which streams its F/A-18 pilots transfer onto the Hornet directly from the turboprop.

comfortable; the stick is precise and soft, the perfect compromise at all speeds considering that to save weight, the flight controls maintain the traditional cable system (the ailerons are hydraulically assisted and the roll spoilers hydraulically powered).
The final part of this flight showed the embedded simulation capability in the air-to-ground field, including a synthetic air-to-ground radar mode. I had the opportunity to see how the avionics system simulates the delivery of bombs with a level profile, and with 30° dive profile (using the CCIP mode), then the launch of unguided rockets, and finally a strafing run. It's amazing to see how real the manoeuvres appear, the representations in the HUD, and the ability to switch the right MFD to the instructor page and look in real time at the results of the firings, having ready the distance of the hit from the target and its direction. It must be remembered that, besides the virtual capability, the PC-21 has a real capability to carry external stores – its five underwing hardpoints can carry up to 2,535lb (1,150kg), such as two ferry tanks of 250 litres (444lb) each.
It's now time to land, and we approach runway 25 flying over the lake, the flaps are lowered and then the landing gear below 180kts (333 km/h). The engine is set as required to maintain the correct position of the speed indicator in the HUD. On final approach, we select flaps to the land position (34°) and the speed decreases gently until the touchdown at 87kts (161km/h). With a normal use of the brakes we slow down rapidly, and clear the runway on the right to taxi back to the Pilatus flight line. Our flight lasted 60 minutes, and we landed with some 600lb of fuel still in our tanks.
After lunch, a second flight showed the capability of the embedded simulation for air-to-air training. We used the datalink system of the PC-21, which, exchanging the data between the aircraft, allows the system to represent the signals as contacts on a radar screen, shown on one of the MFDs. HB-HZC is ready for us on the ramp, and this time we're joined by a second aircraft. Our configuration, fuel on board and take-off weight are the same as in the morning. We take-off from runway 07 with a ten-second separation, and we head southwest to the Schratte area over the glaciers around the Finsteraarhorn (14,105ft/4,274m). We will fly at about 15,000-25,000ft (4,545-7,575m), starting with a series of turns and lazy eights in close formation to show the behaviour of the aircraft, which again performs and handles like a jet, with speed remaining in the range of about 150 to 300kts (278-555km/h). It's really difficult to realise we are flying two aircraft with a propeller in the nose. Then the formation splits for some beyond visual range engagements. The datalink works perfectly, and gives us the position of our 'enemy' on the radar screen, but also on the moving map, with a red triangle.
In the first run, head on, with the radar in range while scan mode, we can use a Fox 3 missile (typically a radar-guided missile in the AMRAAM class) firing within its maximum range, and (of course) we get a 'kill'. In the second run, the radar is in track-while-scan mode, and the missile is fired outside the range, showing as it goes loose from its target. A second phase is dedicated to air combat within visual range, with a target that manoeuvres at a maximum of 3 g, with 150kts as minimum speed. A first engagement foresees the use of a Fox 2 missile, a typical infrared-guided weapon, such as the AIM-9L Sidewinder, with both our target and us flying low and high 'yo-yos'. The system replicates the missile launch procedures very well, including the acoustic tone in the headset. However, because I'm not used to (or trained on) this avionics suite, it's really hard to cope with all the modes and information that are available. Finally, a third run is dedicated to the use of a gun in air-to-air mode. In this case, visibility from the back seat is not the optimum, and I have to follow part of the engagement through the HUD repeater, as it happens just in front of us.
Once this exercise is completed, it's time to head back to Buochs for the final landing. We touch down on runway 07 after 45 minutes, with some 750lb of fuel still in the wing tanks.

15 switches and buttons offering a wide variety of control options, including radar modes and radar target selection, weapons release, boresight missile, chaff and flare, and more. They, as well as the HUD and radar display, can be configured to the needs of the customer, for example replicating the Typhoon, F-16 or F/A-18 controls.

The embedded simulation capability includes the ability to operate synthetic air-to-air and air-to-ground radar representations (simulating the APG-65, APG-68 or other radar systems), real time datalink, simulated stores management and use of simulated weapons for air-to-air and air-to-ground, including onboard synthetic target generation, simulated chaff and flare, and radar warning receiver. The system allows the cockpit configuration to be split to simulate systems failure or data degradation, and includes a mission data recorder with video, audio and data recording.

Integrated Training System

An Integrated Training System (ITS) is a must in the training sector, as it offers further reductions in training costs. The Pilatus ITS is formed by various elements. The ground-based training system includes training documents and aids, computer-based training, personnel training, synthetic training devices, and all studies that take the student from zero to the first flight, and beyond. The hardware is formed by the Aircraft Systems Trainer, the Integrated Procedure Trainer and the Flight Training Device. The latter is a full simulator with the cockpit housed inside a dome, capable of providing a 320° angle of view (or even more if required).

When preparing for flight training, a student can prepare all of their flight plans using the Mission Planning System, which manages navigation, communication, the radar, weapons, targets and other data. All the information selected is used by the


RESCUE
DANGER
EJECTION SEAT
DANGER
DANGER
STEP BELOW



Both cockpits have three NVG-compatible multifunction displays; the front cockpit has a head-up display (HUD) and the aft cockpit a HUD repeater. The stepped cockpit, with a front canopy that can resist birdstrikes at high cruise speeds, creates good all-round visibility for both student and instructor. The pressurised cockpit is equipped with an anti-g system and two Martin-Baker Mk-CH16C zero/zero ejection seats.

system to prepare routes and scenarios. Next all the mission data is transferred into a Removable Memory Module, also simply called a brick, a 64Gb cassette that can be inserted in the aircraft, or in the simulator Mission Data Recorder (MDR). During the mission (real or simulated), from the avionics switch-on to the switch-off, the MDR records all the data and parameters, including full colour images from the HUD and the MFDs.

Post-mission the student takes the brick from the aircraft and goes to the debriefing phase, where – thanks to the Mission Debriefing System (MDS) – they, together with their instructor, can review all the phases of the flight. They use three different screens: one dedicated to the HUD, another to a 3D graphical representation of the mission and a third dedicated to the cockpit MFDs. The MDR records all the parameters, so it can also display data from pages that were not selected by the pilots during the flight. The MDR runs on a commercial off-the-shelf high capacity computer and can display a maximum of four sorties together.

During the mission, the instructor (who can fly either in the front or in the aft seat, according to the training needs) is able to isolate the two cockpits to access the aircraft's library and sensor data and make modifications without the students knowing. This means the instructor can modify the mission, introduce failures or change parameters, and even the flight parameters of other synthetic enemy aircraft involved in the mission.

Simulation

In air-to-air training missions, the MFDs can show (with graphics quite similar to those of F-16 or to other aircraft, according to the customer's needs) various missile modes (generic short range infrared-guided, or generic medium range radar-guided missiles) and gun modes in lead-computed optical sight or continuously-computed optical sight, with sound tones in the headset if needed. When flying air-to-air against another PC-21, the datalink allows each aircraft to see the other in the virtual radar system, in the same way that it would if they had a real radar.

In air-to-ground training activity, the simulation makes it possible to fly against pre-designated ground targets releasing virtual bombs with continuously computed release point or continuously computed impact point (CCIP) techniques, and it is possible to release with dive toss or with CCIP for unguided rockets. The synthetic air-to-ground capability of the radar is included.

In both air-to-air and air-to-ground roles, the instructor can select the On-Board Scoring System page on an MFD, which provides real-time (and post-flight) results in terms of the success of the weapons used against the targets engaged during the mission. Air-to-ground scoring also provides a virtual and range-typical "o'clock score" with distance in feet from the desire mean point of impact. The scoring meticulously records all relevant aircraft parameters during the moment of weapon release, like speed, dive-angle, ground speed and range to the target, giving the instructor the opportunity for immediate analysis and feedback to the student.



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"Roll spoilers, located on the wing, operate in conjunction with the normal, but hydraulically-boosted, ailerons."



2

The ground-based training system and the aircraft are complemented by an integrated logistic support system, which grants a very high level of efficiency of the fleet.

Conclusions

The immersion in the PC-21 world showed us a really surprising aircraft. This aircraft cannot be simply considered an improvement of the previous PC-7 and PC-9 families. It goes beyond the traditional basic turboprop trainer concept, and clearly enters the field of advanced trainers in terms of performance and avionics. This author considers it an aircraft with two faces: one is that of a basic turboprop trainer, easy to handle and with comfortable speeds in many critical parts of the flight envelope (especially in the landing phase) that are suitable even for young pilots with very limited flying experience. The second is a high performance aircraft that cruises at relatively high speeds, and boasts an avionics suite worthy of the best advanced jet trainers. The embedded simulation capability, and the possibility of in-depth debriefings offered by the system, is quite remarkable. The best testimonial is that the Schweizer Luftwaffe passes PC-21 students directly onto the F/A-18C Hornet as a standard pipeline.

Of course, the PC-21 cannot completely replicate an advanced jet trainer as its speeds and performances at altitudes above 15,000ft (4,572m) to 25,000ft (7,620m) cannot match those of its LIFT competitors, such as the Alenia Aermacchi M-346, the KAI T-50 or the BAE Hawk. Consequently, some PC-21 operators, such as Singapore, Saudi Arabia and the UAE, still operate LIFT aircraft. Using a PC-21 for an entire LIFT phase could mean a longer training phase at an operational conversion unit than if a LIFT jet was also used.

A real evaluation on the two different systems can be made only by each air force. Some may decide it is important for a LIFT to provide high speeds, altitudes and energy, to get the students used to the performance of frontline jets. Others may consider it a waste of money to acquire and operate a LIFT jet, when you can carry out nearly the whole military training on the PC-21 training system. According to Pilatus, the PC-21 flying cost per hour is about 40 times cheaper than that of a modern fighter.

Any decision also depends on the traditions and attitudes of the air forces' decision makers. In any case, Pilatus seems to be leading the field – as production at Stans goes on, and an increasing number of new potential customers show their interest in this little Swiss jewel.

PILATUS PC-21 CHARACTERISTICS

DIMENSIONS

Length: *11.23m (36ft 11in)*

Wingspan: *9.11m (29ft 11in)*

Height: *3.75m (12ft 4in)*

Wing area: *14.9m² (160.4ft²)*

WEIGHTS

Basic empty: *2,340kg (5,159lb), depending on configuration*

Max take-off weight *(aerobatic): 3,100kg (6,834lb)*

Max take-off weight *(utility): 4,250kg (9,370lb)*

PERFORMANCE
(maximum take-off weight aerobatic, standard ISA conditions)

Take-off distance *(SL, 50ft obstacle): 725m (2,380ft)*

Landing distance *(SL, 50ft obstacle): 900m (2,953ft)*

Max rate of climb *(SL): 4,250ft/min (1,295m/min)*

Max operating speed: *370kts (685km/h, Mach 0.72)*

Max cruise speed *(SL): 323kts (598km/h)*

Max cruise speed *(10,000ft): 337kts (624km/h)*

Design dive speed: *420kts (778km/h)*

Stall speed *(clean): 92kts (170km/h)*

Stall speed *(gear and full flap): 81kts (150km/h)*

G loads *(acrobatic): +8/-4*

G loads *(utility): + 5/-2.5*

Max range: *720nm (1,333km)*

Max endurance: *2.5 hours*

Ceiling: *38,000ft (certified to 25,000ft)*

Data: *Pilatus*

3



1 Pilatus claims the PC-21's flying cost per hour is about 40 times cheaper than that of a modern fighter, helping air forces download training from more expensive lead-in fighter trainers. 2 The primary flight display is selected in the middle multifunction display. The moving map, navigation and tactical display or synthetic radar display are on the left. On the right is the engine and fuel data display, which can also display simulated weapons. *Riccardo Niccoli*
3 Sleek looks, even on the ground, reflect Pilatus' aim with the PC-21 of creating a trainer that combines the advantages of a light turboprop trainer with the handling and performance of a jet trainer. *Riccardo Niccoli*



Feel the

Nigel Pittaway provides an update on the Airbus Helicopters H145M

With two customers for its H145M medium-sized armed helicopter already on its books, Airbus Helicopters is eyeing the international market for further sales, from the United States of America to Australia.

Formerly known as the EC645 T2 before Eurocopter was rebranded as Airbus Helicopters, the H145M is being offered as a solution to military requirements ranging from light troop transport, through the iterations of intelligence surveillance and reconnaissance (ISR) platform, special forces support, to light gunship.

The type is now entering service with Germany's Luftwaffe in the special forces support role and the first two machines for the Royal Thai Navy were handed over in April this year.

Description

The H145M can trace its heritage back to the Bk117 first developed in the 1970s and is a development of the UH-72A Lakota currently being delivered to the United States Army, but has the Fenestron tail rotor and composite tail boom similar to the EC135 series and an increase in maximum take-off weight (MTOW) of 115kg (330lb) over the earlier variant.

Brochure figures suggest that MTOW is now 3,700kg (8,157lb), with a useful load of 1,770kg (3,900lb). Two pilots and up to ten troops can be carried, with the cabin being accessed by large sliding doors on either side, and the rear clamshell doors of the Bk117/EC645 have also been retained.

The helicopter is powered by two dual-channel, FADEC-controlled Turbomeca Arriel 2E engines, each rated at 894shp (667kW) at take off power, providing a fast cruise speed of 132kts (244km/h) and a maximum range of 357 nautical miles (662km).

The cockpit is night vision goggle (NVG) compatible and incorporates Airbus Helicopters' latest Helionix digital avionics suite and fully integrated Garmin GTN750 GPS/NAV/COM/MFD units. The helicopter has a four-axis autopilot, weather radar and an electro-optical system (EOS) mounted in a turret under the nose.

The H145 also has an electronic warfare self protection system, which consists of a missile approach warning system, with sensors on either side of the cabin looking at both forward and rear hemispheres; together with up to four chaff and flare dispensers mounted on the skids, each capable of holding 30 countermeasures.

Fuel is carried in self-sealing tanks, the main rotor blades have additional protection and armour plating for the crew against 7.62mm weapons is standard equipment. Additional armour for the cabin can be added in kit form, albeit with a weight penalty of 200kg (441lb).



Weapons

The H145M is capable of being armed with door mounted machine guns, including the standard MAG-58 7.62mm weapon, or Dillon M134D Gatling Gun. Removable pylons are attached to either side of the cabin, each capable of carrying up to 210kg (460lb) of external stores.

Weapons currently cleared for carriage on the pylons include the 12.7mm FN Herstal HMP400 gun pod and/or Forges Zeebrugge FZ233 7-shot lightweight rocket pod. So far, weapons integration has been self-funded by Airbus Helicopters, however work is now also under way to integrate the Roketsan CiRiT

1 The five H145Ms ordered by the Royal Thai Navy in September 2014 are due to be delivered by the end of this year. The first two were handed over at Airbus Helicopters' facility in Donauwörth in the spring, and remain in Germany for pilot training. *All photos Nigel Pittaway* **2** Five of the 15 H145Ms that will be operated by the Luftwaffe on behalf of the Kommando Spezialkräfte Bundeswehr (KSK) in the special forces role have now been delivered.



3

2.75in (70mm) laser-guided rocket at the request of a customer and the manufacturer is also working on the integration of the Nexter NC 621 20mm cannon pod.

To facilitate the use of CiRiT, a laser designator will be integrated into the nose-mounted Wescam MX-15HD EOS, enabling a range of future laser-guided weapons to be used.

In addition, the H145M is one of three baseline Airbus Helicopters platforms which will be integrated with the company's new HForce integrated weapons system initiative, the other two being the H215 (Ecureuil/ Squirrel) and H225 (Super Puma).

HForce

HForce is an Airbus Helicopters-led innovation, which adds a flexible and fully-integrated weapons system to the three baseline helicopters, including the H145M. The system is a collaborative effort between Rockwell Collins, which provides the hardware, and Airbus Helicopters, which has developed the software and therefore owns the intellectual property.



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The system interfaces with the H145M crew either via a Thales Scorpion Helmet Mounted Sight Display (HMSD) or the helicopter's EOS system. Armament includes a range of air-to-ground and air-to-air missiles, rockets and guns.

Christian Fanchini, Senior Operational Marketing Manager, Airbus Helicopters, said: "The system is a 'plug and play' weapons system that is designed to be incremental and modular. The crew captain is the gunner, firing through the EOS both day and night. The pilot flies, the gunner fights, just like an attack helicopter."

HForce is available in four basic options: Option '0' is where the helicopter is fitted 'for but without'; where the fixed parts and harnesses are installed but weapons are not added unless dictated by a later operational requirement. Options 1, 2 and 3 are incremental increases in capability, up to laser-guided rockets and air-to-air weapons.

The first firing campaign, using an H225M, was conducted in Belgium in May and June of this year and the first flight of a H145M fitted with the system is expected to occur early in the New Year. System qualification on all three helicopters is scheduled for completion by the end of 2017.

Marketing Campaign

Germany became the launch customer for the H145M (then still known as the EC645 T2) in 2013, with an order for 15 aircraft to be operated by the Luftwaffe on behalf of the Kommando Spezialkräfte Bundeswehr (KSK). The first helicopter was handed over in December 2015 and, as of June, five of the 15 had been delivered.

The Royal Thai Navy became the second customer in September 2014, with an order for five aircraft. The first two were handed over at Airbus Helicopters' facility in Donauwörth on April 29, but will initially remain in Germany, for pilot training with the Airbus Helicopters Training Centre at Manching. All five helicopters will be delivered to Thailand by the end of the year.

Airbus Helicopters hopes to keep selling UH-72A Lakotas (and possibly H145Ms) to the US Army but has its eye on a number of campaigns around the world, including a future requirement in Australia, which is looking to acquire a fleet of armed, light reconnaissance and attack helicopters for the Australian Army around 2025, to provide mobility support for Special Forces and which can be readily deployed by Royal Australian Air Force C-17A Globemaster aircraft.

Airbus Helicopters' Head of H145M Programme, Mark Henning, explained: "Most customers from our point of view are not likely to be able to afford dedicated transport and attack helicopters. So we are targeting Special Operations forces, with a dedicated mission capability. But the same basic airframe can also perform utility transport and ISR missions and, with HForce, it has an attack helicopter capability."

3 The cockpit is fitted with fully integrated Garmin GTN750 GPS/NAV/COM/MFD units and Airbus Helicopters' latest Helionix digital avionics suite. **4** A laser designator will be integrated into the nose-mounted Wescam MX-15HD electro-optical system, enabling a range of future laser-guided weapons to be used. **5** A Dillon M134D Gatling Gun is among the standard weapons on the H145M. **6** Weapons currently cleared for carriage on the removable pylons attached to either side of the cabin include the 12.7mm FN Herstal HMP400 gun pod and/or Forges Zeebrugge FZ233 7-shot lightweight rocket pod.

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Throwing Down

Russia's new MC-21 is packed with new technologies in an attempt to take on the Airbus and Boeing duopoly. Piotr Butowski reports



the Gauntlet

The Irkut MC-21 was created as a breakthrough product offering a reduction of the cash operating costs (COC) by 12-15% compared to the Airbus A320, including fuel consumption, which will be 24% lower. In comparison with the re-engined A320neo on a typical 1,000 nautical miles (1,852km) route, the MC-21 is to burn 8% less fuel and the COC will be 5% lower.

Even the designation reflects the great ambitions of this aircraft: MC-21 in Russian means Magistralnyi Samolyot 21. vyeka, or Mainline Aircraft for the 21st century. In fact, the Cyrillic transcript should be translated as MS (it was referred to as the MS-21 by foreign publications initially) but later Irkut specified the international abbreviation of its design as the MC-21.

The 12-15% lower fuel burn figures have been present in Irkut's declarations since the days when oil was twice as expensive as it is now, but with the current, lower price of fuel the difference in operating costs between current and next-generation aircraft should decrease.

Composites

The most important feature of the MC-21 is its sophisticated aerodynamics, with a new very high aspect ratio wing of 11.5 (compared to 9.39 for the A320 and 9.44 for the 737NG). At Mach 0.78, the MC-21's lift-to-drag ratio is claimed to be 5.1% better than the A320 and 6% better than the 737NG; at Mach 0.8 the differences are even greater, at 6% and 7% respectively. Making such a wing using conventional metal technology is impossible (because the wing would be very heavy), therefore it has be made of composites.

Composites make up 35-37% of the MC-21 airframe's weight. Many years ago, at the start of the project, Irkut Corporation's President Oleg Demchenko said: "The MC-21 faces two major technological challenges: composite materials and engine." Composite materials in airliner components of secondary importance – fairings, hatches,

The Russian prime minister Dmitry Medvedev presents the initial MC-21-300, the first large airliner in Russia for a quarter of a century, with which the Russians want to compete with the popular Airbus A320 and Boeing 737.
All photos Piotr Butowski

THE MC-21'S ORIGINS

Why has Irkut, a company formed around an aircraft factory in remote Irkutsk, undertaken a large and exceptionally demanding programme to produce a passenger aircraft? Irkut's 'cash cow' is the Su-30MKI fighter, which has provided financial stability for the company for 20 years. But relying on only one product – moreover one dedicated for the changeable military market – is risky, so Irkut looked for another product to diversify. Its first attempt was the large jet-powered Be-200 amphibious aircraft. Irkut invested a lot of money in this project, but it turned out that enthusiastic supporters of the Be-200 exaggerated potential demand for such an aircraft. After several years, Irkut quietly got rid of the Be-200, transferring its production to Taganrog. In 2004, Irkut purchased the Yakovlev design bureau in Moscow, along with that company's very successful design of the Yak-130 jet trainer aircraft. That has provided stable profit for Irkut for many years, however it is a small aircraft and the money, in the company's scale, is also small.

Really big and stable money lies in the civilian market. The Yakovlev design bureau had experience with passenger aircraft; in 1966 it made the Yak-40 regional jet for 27-40 passengers and in 1975, the Yak-42 for 80-120 passengers. In Yakovlev's design portfolio there were the next-generation Yak-142 and Yak-242 – and it was the latter that eventually became the MC-21.

The Yak-242 project was first announced at Le Bourget in 1993. Powered by two PS-90A12 engines, the aircraft was to seat 132-180 passengers and was scheduled to enter airline service by 1997. That did not happen because there was no money for its development at that time. Almost ten years after the Yak-242's launch, in the autumn of 2002, the Rosaviacosmos state agency announced a competition for the design of a new medium passenger aircraft – the contest being called BSMS (Blizhne-Sredniy Magistralnyi Samolet, short-medium mainline aircraft). Subsequently, on July 21, 2003, the BSMS was won by the MC-21 design submitted jointly by Yakovlev and Ilyushin, developed from the Yak-242, with a new high-speed wing and a fuselage of enlarged diameter. Rivals were the Tupolev Tu-204-300, Myasishchev M-60-150 and the design of a passenger version of the Il-214 transport aircraft, submitted jointly by Ilyushin and Irkut. After further reshuffles, Ilyushin quit the MC-21 programme and after the purchase of Yakovlev by Irkut, the MC-21 became Irkut's design. At that time, in the mid-2000s, it was planned that the aircraft would be certified and enter service by 2010.



1

control surfaces, high-lift devices – have been commonplace for decades. But load-bearing composite construction is a novelty of recent years. The breakthrough was the Boeing 787 Dreamliner, which is virtually all made of composites, and this was followed up by the Airbus A350. The smaller Bombardier C Series, like the MC-21, has only a composite wing.

Vacuum Infusion

Typical for current aircraft composite constructions is autoclave technology, in which pre-impregnated composite fibres (pre-pregs) are applied in layers onto a mould and then pressed under pressure in an autoclave. The composite wing for the MC-21 is made using vacuum infusion. This has not been used before in the aircraft industry for producing large components but it is used in other sectors (paddles for wind turbine blades are made using this technology, for example). Vacuum dry carbon fibre tapes, laid in layers at various angles onto a mould, are used. Then the elements are assembled in a larger, integral construction. Next, Thermo Infusion Automated Center (TIAC) liquid epoxy resin is infused into the dry construction and thermal processing in the oven is simultaneously performed.

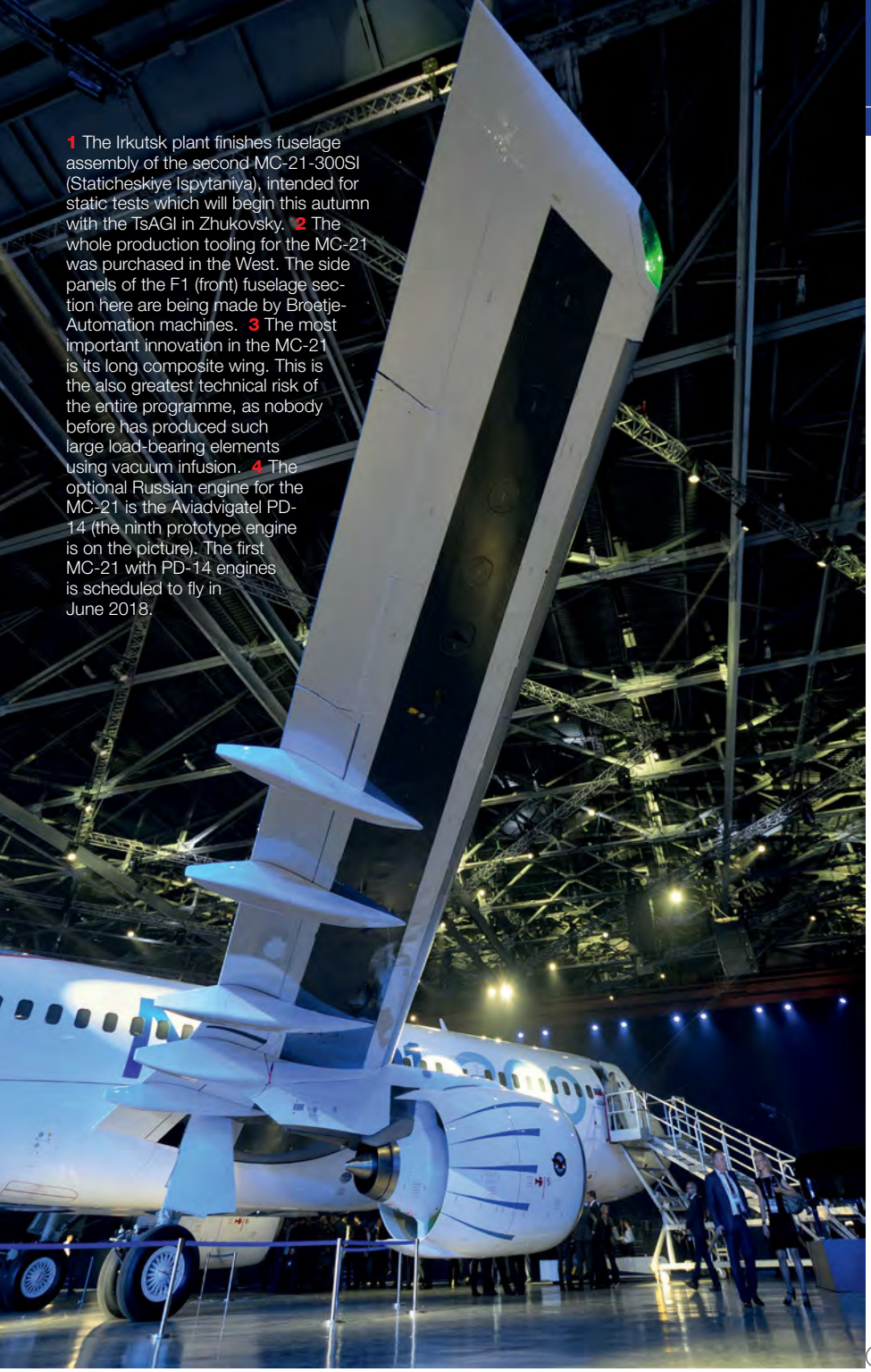
The main advantage of vacuum infusion technology is the possibility of making large integral structures in a single cycle. Besides, production tooling for the infusion is much cheaper than for an autoclave, and costs of materials are also lower. There is risk, like in everything done for the first time. The choice of the right materials and precise dosage of the epoxy resin in proper spots, amount and temperature are necessary. There is the hazard of displacement of dry material (in contrast with an impregnated material, used in the autoclave) during the assembly. To avoid that, a very thin thermoplastic veil that functions as a binder is added.

When the Boeing 787 programme was starting, the Americans stated that liquid resin infusion technology was too immature to be used for large load-bearing constructions. A few years later, the Russians stated that only with this technology would they be able to make a technological leap. The partners who assisted the Russians master and then perfect the composite technologies for the MC-21 are Fisher Advanced Composite Components (FACC) and Diamond Aircraft, both from Austria. In May 2011, FACC made the first down-sized prototype wing torsion box for AeroComposit-Ulyanovsk, the company established by the United Aircraft Corporation (UAC) on December 2, 2008 purposely to develop and introduce production composite elements for the MC-21. That structure underwent strength trials at TsAGI at Zhukovsky, after which it was modified to eliminate stress concentrators. In December 2011, Diamond Aircraft delivered its prototype of the wing for the MC-21 to Ulyanovsk.

The AeroComposit-Ulyanovsk plant is the only one that uses vacuum infusion technology. It produces load-bearing elements of the MC-21: the wing torsion box, centre wingbox and wing skins. The construction of the entirely new plant at Ulyanovsk began in November 2011. On reaching full production capacity, it will be able to produce kits for 100 aircraft per year.



2



1 The Irkutsk plant finishes fuselage assembly of the second MC-21-300SI (Staticheskiye Ispytaniya), intended for static tests which will begin this autumn with the TsAGI in Zhukovsky. **2** The whole production tooling for the MC-21 was purchased in the West. The side panels of the F1 (front) fuselage section here are being made by Broetje-Automation machines. **3** The most important innovation in the MC-21 is its long composite wing. This is the also greatest technical risk of the entire programme, as nobody before has produced such large load-bearing elements using vacuum infusion. **4** The optional Russian engine for the MC-21 is the Aviadvigatel PD-14 (the ninth prototype engine is on the picture). The first MC-21 with PD-14 engines is scheduled to fly in June 2018.

attractive to operators looking to shorten the turnaround (disembark and embark) time. Irkut ordered Zodiac Aerospace to conduct an experiment which showed that increasing the width of the aisle from 19in to 22in decreases turnaround time by 11%, from 29 to 25.7 minutes (for the MC-21-200 with 168 passengers aboard). Further savings are provided by hinged overhead luggage compartments, which make it easier to get the hand luggage in and out. Irkut declares that the MC-21 has a turnaround time of up to 20% faster than its rivals.

Passenger comfort is increased by a new air conditioning system made by Teploobmennik. While cruising at 39,000ft (11,877m), it maintains pressure equivalent to the altitude of 6,000ft (1,830m) instead of the standard 8,200ft (2,499m). The cabin windows are larger than usual. The aircraft will meet all current and future environmental noise and emissions requirements.

Foreign Involvement

The MC-21 would not have been completed without the participation of foreign companies. The Russian Prime Minister Dmitry Medvedev, who took part in the roll-out ceremony in Irkutsk in June, has separately addressed the foreign suppliers participating in the MC-21 programme. Medvedev said: “The fact that not only our best aircraft manufacturers, but also many foreign companies participated in the project, is very important for us. We hail those businessmen who work in Russia, which now also are in this hall, and try to reach impressive success together with our country.”



4

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Irkut selected the Pratt & Whitney PW1400G geared turbofan engine for the MC-21. The first version, the MC-21-300, is powered by two PW1431G engines rated at 31,000lb (137.9kN) on take-off; the shortened MC-21-200 version, to be developed later, will be powered by PW1428G engines rated at 28,000lb (124.5kN). Pratt & Whitney certified the PW1400G engine in the United States in early May 2016; the Russian validation of the certificate is planned for the end of the year.

Incidentally, the Ulyanovsk factory will also use vacuum infusion technology to make composite wings for the new Russian UAV, the Altair.

KAPO-Composit, established at Kazan within the Kazan Aircraft Plant, sticks to the conventional autoclave technology and produces ailerons, spoilers, wing flaps and fairings of glass-fibre plastic for the MC-21. The plant, opened in July 2013, will produce the same components for the Sukhoi SSJ-100 Superjet and new Russian military transport aircraft. A third company, PM Technologiya of Obninsk (not a part of AeroComposit), makes the MC-21’s fin and tailplane’s torsion. Obninsk has been the traditional manufacturer of aircraft composites in Russia for many years; it has produced components for the PAK FA fifth-generation fighter, among others.

Comfortable Cabin

The MC-21’s fuselage is a conventional, metal construction. The Russians consider that making the fuselage from composites is justified for aircraft of 787 and A350 size with the current level of technology, but that for smaller aircraft, including the MC-21, it is better to stick with metal fuselage construction.

However, the MC-21 has a wider fuselage than its rivals; the passenger cabin of the MC-21 is 3.81m (12.5ft) wide. Additional width can be used to improve the comfort of the passengers thanks to 18.5in-wide (469mm) seats, leaving 20in (508mm) for the aisle (in economy class with six seats in the row). In another option, 18in-wide (457mm) seats can be used, with the aisle widened to 22.5in (571mm). The latter option will be







1 A mock-up of the future passenger cabin of the MC-21. In typical configuration, the MC-21-300 will take 163 (16 business and 147 economy class), and a maximum 211 passengers. **2** The MC-21 avionics (the cockpit mock-up is pictured here) has been integrated by the UAC Integration Centre with participation of other Russian companies; foreign participants deliver only separate components. **3** The MC-21 main undercarriage leg has two wheels as standard; however, it is possible to order four-wheel boogies to enable operation from poor-quality runways.

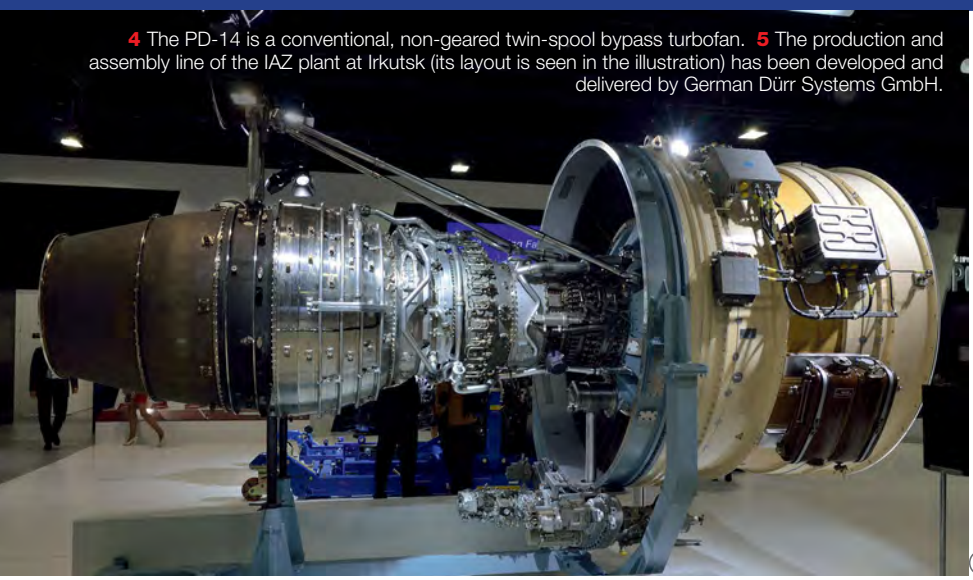
Even more important than the engine is the overseas participation in the MC-21's production: the entire manufacturing tooling is foreign. For the MC-21, the Russians have made large investments in a thorough modernisation of production facilities, purchasing the tooling in the West. Dürr Systems from Germany created and delivered the fuselage assembly and final assembly lines to the Irkutsk plant. The rear fuselage and empennage assembly line at the Aviastar-SP plant at Ulyanovsk was built by ThyssenKrupp of Germany and the riveting machines were delivered by Gemcor of the United States. Other large suppliers of production tooling for the MC-21 include Broetje-Automation and Handtmann of Germany. The entire tooling of the AeroComposit plants at Ulyanovsk and Kazan, as well as raw materials for production of composite constructions, are delivered from abroad. For automated dry fibre placement and automated assembly at Ulyanovsk, tooling made by MTorres in Spain and Coriolis Composites in France was purchased and the TIAC system, made by Stevik also from France, is used for infusion and kilning. Resin, fibre and pre-pregs are being delivered by Hexcel and Cytec from the United States.

Russian Engine Option

When the MC-21 programme started there was no Russian engine of the required class. The Russians therefore launched the large PD-14 engine programme in 2008. The basic PD-14 (Perspektivnyi Dvigatel, or future engine, 31,000lb/137.9kN) version will power the MC-21-300; the de-rated PD-14A version (27,000lb/122.5kN of thrust) will be made for the shortened MC-21-200.

In contrast with the PW1400G, the Russian PD-14 is a conventional (not geared) twin-spool bypass ratio turbofan with a lower bypass ratio of 8.5:1 (the PW1400G has 12:1). The engine core (hot section) features an eight-stage compressor with a compression ratio of 17:1, annular combustion chamber and a two-stage turbine. The dimensions of the engine core have been selected to expand the engine's limits: in future a family of engines rated at 20,000 to 40,000lb (88 to 176.5kN) of thrust is to be developed. The outer (cold) section of the PD-14 comprises a single stage fan, three-stage low pressure compressor and six-stage low pressure turbine. The engine nacelle is short, made of 65% composites, with a lattice thrust reverser.

The key new technology of the PD-14 is a wide, hollow fan blade, the production of which is affected by titanium processing. Hollow blades are also used in all six stages of the low-pressure turbine. Hollow blades enable reduction of the engine weight by 500kg (1,102lb) in comparison with conventional blades, with the weight of the complete engine amounting to 3,800kg (8,378lb). The plant at Ufa developed an indigenous 'patent-clean' technology to produce this blade. Alexander Inozemtsev of the Aviadvigatel company of Perm, who is in charge of the project, claims that in comparison with the PW1400G, the Russian engine will have about 1% higher fuel



4 The PD-14 is a conventional, non-geared twin-spool bypass turbofan. **5** The production and assembly line of the IAZ plant at Irkutsk (its layout is seen in the illustration) has been developed and delivered by German Dürr Systems GmbH.

consumption (independent estimations are less optimistic, saying it will be 5%), but that, "thanks to lighter weight and smaller diameter on the wing of the MC-21, our engine will be 0.5-0.7% better".

By May 2016, nine complete PD-14 engines had been built, which since the first one was launched on June 9, 2012 have accumulated over 250 hours of running. On October 30, 2015, a PD-14 was run in the air for the first time on an Il-76LL flying testbed – that engine has accumulated 22 hours and 22 minutes of operation in the air during 16 flights. Currently the engine is being overhauled before another series of tests in late summer. The first flight of the MC-21 with PD-14 engines is planned for June 2018.

Family of Aircraft

During the MC-21's development the market has changed and accordingly, the planned versions of the aircraft have changed too. In the original plans there were three versions: MC-21-100 for 132 passengers, MC-21-200 for 150 and MC-21-300 for 168. In 2007, the smallest version vanished from the offer, but a new, long MC-21-400 version for 210 passengers appeared instead. The order in which the different versions of the MC-21 are being built has changed too, according to customers' preferences. Initially the plan was to make the MC-21-200 first and then subsequent, longer versions. However, most orders have been for the 5.5m (18ft) longer MC-21-300 version and so it is being made first, with the MC-21-200 afterwards. These are currently the only two versions in Irkut's offer.

The head of the United Aircraft Corporation, Yuri Slyusar, said in Irkutsk that the final decision about the MC-21-400 is not expected soon; market research is still in progress. The problem with this version is that it would require an enlarged wing and modified, uprated engines, while the -200 and -300 versions will be powered by the same engine with thrust regulated only by software. Similarly, the Extended Range (ER) and Long Range (LR) variants for each of the versions remain under consideration. In the more distant future, the MC-21 will also be ordered by the Russian Ministry of Defence and other government agencies, replacing the Tu-214s currently operated as special duty aircraft such as executive, airborne command posts and communications relay variants.



A Game-Changer?

The first MC-21-300 is going to fly early next year, and the first delivery to Aeroflot is planned for the last quarter of 2018. So far, Irkut has collected 175 firm orders and more than 100 options and intents of purchase, with Aeroflot being the launch and largest operator. Only 35 of the ordered aircraft will get the Russian PD-14 engines – they were ordered in June 2012 by the Russian state-owned Rostec Corporation for "other Russian operators" (probably government agencies, including the Ministry of Defence), with deliveries during 2022-2025.

Among firm orders for the MC-21, there are no foreign customers. During the Farnborough International Airshow 2010, the Malaysian investment company Crecom Burj Resources signed a contract for 50 aircraft, but later the contract was quietly turned into an initial agreement; it is not known whether this company still exists. Another worrying fact is the lack of any new orders for the MC-21 since 2013. In the case of the Russian airlines it is no wonder; since 2014, passenger air transport in Russia has been on the decline.

Judging by this it will not be easy for the MC-21 to step between the giants and deprive them of a noticeable share of the market. The example of the smaller Sukhoi Superjet is not encouraging. Eight years after the maiden flight of that aircraft in May 2008, and five years since its service entry, there are fewer than 70 Superjets in regular service now. But the technological innovations introduced in the MC-21, if their advantages are confirmed, may accelerate thinking by Airbus and Boeing about a new aircraft to succeed the 737 and A320.

IRKUT MC-21 CHARACTERISTICS

	MC-21-200	MC-21-300
Length	36.8m (120ft 9in)	42.3m (138ft 9in)
Wingspan	35.9m (117ft 9in)	35.9m (117ft 9in)
Height	11.5m (37ft 9in)	11.5m (37ft 9in)
Passengers, typical two-class configuration	132	163
Passengers, single economy-class configuration	165	211
Maximum take-off weight	72,560kg (159,967lb)	79,250kg (174,716lb)
Maximum landing weight	63,100kg (139,112lb)	69,100kg (152,339lb)
Maximum payload	18,900kg (41,667lb)	22,600kg (49,824lb)
Maximum fuel	20,400kg (44,974lb)	20,400kg (44,974lb)
Range, typical two-class configuration	3,450nm (6,400km)	3,600nm (6,600km)
Cruise speed	Mach 0.8	

Data: Irkut

Samu

Hercules

Matthew Clements visits the 36th Airlift Squadron in Japan



Kanto 21 on the ramp at Yokota Air Base, Japan. The C-130H carries 6,700 US gallons (25,362 litres) of fuel in six integral wing tanks; the external tanks under the wings each have a capacity of 1,300 US gallons (4,921 litres).
All photos Matthew Clements

The 36th Airlift Squadron (36th AS) is the only forward-based tactical airlift squadron in the Pacific Area of Responsibility (AOR), operating the C-130H from Yokota Air Base, Japan. Formerly an Air Mobility Command unit, and a Military Airlift Command and a Tactical Air Command unit before that, the 36th AS is now part of Pacific Air Forces (PACAF) and operates under the 374th Airlift Wing (374th AW).

It maintains a forward presence and supports combat operations by providing responsive movement of personnel and equipment through aerial delivery and assault air and land operations. The squadron operates the C-130H Hercules with mission-ready aircrews to conduct theatre airlift, special operations, aeromedical evacuation, search and rescue, repatriation and humanitarian relief missions.



AIR International spoke with Lieutenant Colonel Andrew Campbell, 36th AS Commander, about the importance of the squadron in the Pacific theatre. He said: "We are a forward deployed asset, assigned to PACAF and United States Pacific Command (USPACOM). During the past several years, the squadron's worked very deliberately [to] advance PACAF's theatre security cooperation though engagement with our allies and partners across the region.

"The C-130H is unique in its versatility. Combat airlift remains our core mission, but the skills we hone for combat also make us especially effective in disaster response and humanitarian assistance. In the wake of disasters like the Great Tohoku Earthquake in Japan, Typhoon Haiyan in the Philippines, or last year's earthquake in Nepal, our C-130s delivered hope.

"This versatile capability is shared across the region. All of our regional partners fly some variant of the C-130 Hercules. Bangladesh, Thailand, Philippines, Australia, Malaysia, Korea, New Zealand and Japan all have C-130s. The personal bonds and interoperability we build during routine engagement exercises are invaluable. We learn from them, and they learn from us, and in times of crisis we deliver life-saving results."

The 36th AS has a long and rich history of operating the C-130, from the legacy C-130E through to the current C-130H fleet. The entire Yokota fleet of C-130H aircraft used to be operated by the 317th Airlift Group (317th AG) at Dyess Air Force Base, Texas. The 36th AS operate under the call-sign Kanto for local training flights and Trek and Repat during deployments and real world operations.

The C-130H

The C-130 Hercules primarily performs the tactical portion of the US Air Force's airlift mission. The aircraft is capable of operating from rough, dirt strips and is the prime transport for air-dropping troops and equipment into hostile areas.

The C-130H has updated Allison T56-A-T15 turboprops, a redesigned outer wing, updated avionics and other minor improvements. The C-130H carries 6,700 US gallons (25,362 litres) of fuel in six integral wing tanks. Under each wing is an external pylon fuel tank with a capacity of 1,300 US gallons (4,921 litres). In June 1974 the US Air Force introduced the first of 308 C-130Hs with the more powerful Allison T56-A-15 turboprop engine. Nearly identical to the C-130E externally, the new engine brought major performance improvements to the aircraft.

The C-130H has a maximum load of either six pallets, 74 litters, 16 container delivery system bundles, 92 combat troops

1 Lt Col John Kerr (pilot/aircraft commander), Capt Max Mallory (co-pilot), Lt Mike Dzyndra (navigator) and SSgt John Denman (flight engineer) in the cockpit of Kanto 21 as it manoeuvres near the Izu Peninsula on the Pacific coast of Honshu, Japan. **2** C-130H 74-1669 assigned to the 36th AS undergoing its extensive two-week inspection by the 374th Maintenance Squadron isochronal inspection team at Yokota, in the ISO dock. **3** The ISO dock inspection on an older C-130H requires 9.7 maintenance hours per flying hour, a figure which will drastically reduce as C-130Js are put into service.





2

MAINTENANCE

The 374th Maintenance Group maintains C-130Hs, C-12Js and UH-1Ns supporting intra-theatre airlift and distinguished visitor transport for Pacific Air Forces and on- and off-equipment maintenance for assigned, transient and Air Mobility Command aircraft. It manages Pacific Air Forces (PACAF) T56 Engine Regional Repair Center and the only C-130 aircraft refurbishment and isochronal inspection programmes in theatre. The 374th Maintenance Squadron provides combat-ready maintenance personnel, equipment and organisational support to inspect, service and repair 14 assigned C-130H aircraft. It maintains mission-ready aircraft to sustain contingency and peacetime missions throughout the Pacific theatre to accomplish US Pacific Command and Pacific Air Forces' tasking, and deploys in joint and combined operations.

The 374th Maintenance Squadron directs on- and off-equipment maintenance, munitions, precision measurement component calibration/repair and aerospace ground equipment for assigned Air Mobility Command and other transient aircraft. It is responsible for the only C-130 isochronal inspection section in the Western Pacific, serving both Air Mobility Command and Air Force Special Operations Command aircraft. It also manages PACAF's Queen Bee T-56 Engine Regional Repair Center.

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> ***"The C-130H is one of the last great pilots' aircraft in the US Air Force. Its pretty easy to fly, but its hard to fly well."***
>
> **Colonel John Kerr, 36th AS Director of Operations**



or 64 paratroopers – or a combination of any of these up to the cargo compartment capacity or maximum allowable weight. Like most legacy aircraft, it has a larger aircrew complement; the C-130H has a crew of five which consists of two pilots, a navigator, flight engineer and loadmaster.

What is the C-130H like to fly? Lieutenant Colonel John Kerr, 36th AS Director of Operations, said: "The C-130H is one of the last great pilots' aircraft in the US Air Force. It's pretty easy to fly, but it's hard to fly well. We have no glass cockpit, we fly low and slow, we take off and land on everything from dirt to the sides of mountains, and it takes effective coordination with the rest of our outstanding crewmembers to get the mission done safely and reliably. In short, there's no other aircraft in the inventory I'd rather fly."

The Role

Colonel Douglas DeLaMater, 374th AW Commander, said: "We operate the oldest C-130 fleet in the active duty inventory, and it's the only active duty C-130H fleet left; the rest are C-130Js. We have 14 C-130Hs and are PACAF'S only Airlift Wing.

"Yokota airmen have been deployed to Afghanistan and Iraq as well as maintaining their mission-ready status right here in PACAF, our forward-deployed AOR, at the same time. The 36th AS and its Hercules fleet have been a key part of the global fight over the last ten years to an extremely significant degree, and we will continue that when the need arises."

The 36th AS C-130H area of operation stretches from Afghanistan and Iraq to Indonesia, Malaysia, Nepal, Bangladesh, Vietnam, Guam and the Korean Peninsula. "Where we are needed transitions and shifts; we operate regularly in Australia and New Zealand doing interoperability exchanges with our partner C-130 operators," Col DeLaMater said. "Airmen within this wing are particularly lucky as they get to operate across a much larger geographical area than many other commands; our AOR covers 50% of the world's surface and we go to every inch of it."

Training

With Yokota located so close to Tokyo, it is completely understandable how the 36th AS can't drop down to 300ft (91m) and conduct low-level training over heavily populated areas, so the squadron often deploy to Bangladesh and Thailand for training. Lt Col Kerr said: "The change in landscape really helps top off our proficiency. When we have brand new pilots and navigators, we tend to take them to Thailand on exercise. Within a different airspace [and] difference hazards, they soon become quite seasoned in their positions. This brings an incredible capability to our always ready squadron.

"Urban environments always provide unique challenges to our training syllabus. Any time we go on the road, we seek opportunities to do NVG [night vision goggles] training in a darker environment. In the US, it is easier to do with vast areas of unpopulated land, here we find ways we can still remain proficient in the use of NVGs."

Disaster Relief

The 36th AS has participated in a number of disaster relief missions in recent years. Operation Tomodachi was a US armed forces assistance operation to support Japan following the 2011 Thoku earthquake and tsunami. The 36th AS participated heavily in the operation, flying several missions carrying personnel, fuel and relief supplies into Sendai Airport after it reopened. During one day of operations, a C-130H from the 36th AS transported approximately 108,026lb (49,000kg) of cargo and 30,000lb (13,607kg) of diesel fuel to the airport. Due to Sendai's location in the middle of



The area of responsibility for the 36th AS is huge, covering 50% of the world's surface, and stretching from Afghanistan to Guam in the Pacific Ocean.

the disaster area, having Yokota's C-130s deliver relief supplies directly into the airport decreased delays in distribution and in turn helped Japanese citizens living in temporary shelters.

Typhoon Haiyan, known as Super Typhoon Yolanda in the Philippines, was one of the strongest tropical cyclones ever recorded, and devastated portions of southeast Asia, particularly the Philippines. At the time of the typhoon's strike in 2013, the 36th AS was returning from an interoperability exercise in Bangladesh. It shifted quickly to a real-world disaster relief mission, with three C-130Hs and a team of 75 personnel heading to Clark Air Base in the Philippines.

Lieutenant Colonel Andrew Campbell, 36th AS commander, recalled: "We delivered a unique mix of airlift expertise ranging from airspace co-ordination to NVG air-land operations at Tacloban. Together with our Philippine hosts and the US Marine Corps, no one else in this theatre could do what we did. We worked together to manage a naturally chaotic situation, employ a mix of assets effectively and maintain 24hr operations in the area. We delivered tons of

374TH OPERATIONS GROUP AND 374TH OPERATIONS SUPPORT SQUADRON

The 374th Operations Group maintains a forward presence by providing rapid responsive movement of personnel, equipment and operational support in the Indo-Asia Pacific Region. It ensures the combat readiness of three operational squadrons using C-130H, C-12J and UH-1N aircraft. It conducts three distinct missions: intra-theatre airlift, aeromedical evacuation and distinguished visitor transport for US Pacific Command and other agencies in support of national security policy.

The 374th Operations Support Squadron (374th OSS) maintains a forward presence in the Western Pacific, supporting US Pacific Command interests. It provides flight operations, intelligence, combat survival, aviation resource management, aircrew training, life support, weather forecasting and observing, combat tactics, mission scheduling, airfield management and air traffic control, and supports group staff and the two airlift squadrons operating UH-1N, C-12J and C-130H aircraft.

The 374th OSS is one of three squadrons in the 374th OG, providing airlift capability around the Pacific Theatre. It is the only squadron in the group that doesn't have aircraft assigned to it. They are the squadron which provides key equipment and logistics that contributes to overall mission success.

Lieutenant Colonel Andy DeLello, 374th OSS Commander, explained: "We are to the Pacific what Ramstein is to Europe. Between the flying squadron and Pacific Air Forces, we are the middle ground that supports mission success. From local flying and exercise engagements, weather planning, to intelligence information. We also develop local flight routes and provide tactical planning products and expertise, flight equipment, gear for survivability, parachutes, helmets and night vision goggles. We really are a jack of all trades and we provide the necessary products to the aircrew to accomplish their mission effectively and safely.

"The OSS provides airfield capability not only to the wing aircraft but the transient strategic aircraft (C-5s, KC-10As, C-17As, and KC-135Rs). During FY2015, Yokota processed 77,103 passengers, an average of 6,425 a month. The 374th Airlift Wing flew 3,791 missions, which averaged 316 a month. In total 12,600 tons of cargo were processed, averaging 1,050 tons a month."



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aid and airlifted thousands of people out to the reception centre at Manila. Our airmen provided lifesaving support, very early on in that crisis."

Operation Christmas Drop

In addition to real-world operations, the 36th AS also takes part in important regional training events. One example was Red Flag Alaska, in which the unit participated in August 2015 in an airfield seizure exercise alongside forces from the UK, Australia, New Zealand, Thailand, the US Army and Japan. Lt Col Campbell described the quality of realistic combat training received during the event as "unparalleled".

An important tradition is Operation Christmas Drop. This exercise started in 1952 when the crew of a 54th Weather Reconnaissance Squadron WB-29, flying a mission to the south of Guam over the Micronesian atoll of Kapingamarangi, saw the islanders waving to them. They quickly gathered some items they had on the aircraft, placed them in a container with a parachute attached and dropped the cargo as they circled again.

Since then, Operation Christmas Drop has become the longest-running US Department of Defense air-drop mission in full operation, and the longest-running humanitarian airlift in the world. Each December, C-130 crews from the 374th AW fly to Andersen Air Base on Guam to airlift donated goods for islanders throughout Micronesia.



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Over a two-week period, the people of 56 islands throughout the Commonwealth of the Northern Mariana Islands, Federated States of Micronesia and Republic of Palau, including Chuuk, Palau, Yap and the Marshall Islands – an area two-thirds the size of the continental United States – receive boxes containing toys, clothing, fishing equipment, sporting goods, food items, tools and other equipment that help people in the islands with their livelihood.

Lt Col Kerr said: "It's an unparalleled training opportunity for our crewmembers to go to unfamiliar areas, make a thorough and professional airborne assessment of where they will be dropping, based on winds, surf and the location of personnel and structures on the ground, and then just get the job done. It really lets [crews] flex their muscles in a professional sense, and it is a great development tool for their further careers in tactical airlift.

"On one Operation Christmas Drop sortie, we were hitting the last island of a pretty long mission and about to head home to Guam. Because it's such a remote area, all communications are via high frequency [HF] radio. Most of our communication is with our home base back on Guam, but some of the islands have HF sets they can use to talk to us as we perform the airdrop. On this particular island, the HF radio was located in the village school, and they had gathered all the children in the building so they wouldn't be tempted to run out into the area where we were air-dropping.

"We kicked a bundle out, the islanders recovered it with no issues, and we started our climb-out for the long trip back to Andersen. As we departed, they activated their HF, and the room full of school kids

serenaded us with Christmas carols and shouts of 'thank you' and 'merry Christmas'. There are not a lot of opportunities to have that type of direct contact with the people you help in this business. It was an experience I'll never forget."

Lt Col Campbell also spoke about the benefits of Operation Christmas Drop. He said: "This demonstrates our ability to execute safe, affordable and accurate airdrop operations without a tactical control party on the ground or a pre-surveyed drop zone. While rotary wing assets are often well suited to humanitarian assistance and disaster relief resupply, the vastness of the Pacific demands a resupply platform like the C-130 that can range thousands of miles."

ISO Inspection

Every legacy Hercules (C-130E or C-130H) must undergo a unique and extensive two-week inspection every 540 days, and when examples from Yokota and Kadena Air Base require this work, the responsibility falls to the 374th Maintenance Squadron (374th MXS) isochronal inspection team at Yokota, known as the ISO dock.

When the ISO dock performs an isochronal inspection, they strip most of the content off the aircraft's frame and body to inspect it 100%. The purpose of the ISO



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1 Kanto 22 flying over mainland Japan. Restrictions on low flying mean the squadron regularly deploys to Thailand and Singapore for training. **2** Loadmasters SSgt Joel Brenner (left) and SrA Nathanial Bennett (right) securing an airdrop bundle on Kanto 21. The C-130H has a maximum load of either six pallets, 74 litters, 16 container delivery system bundles, 92 combat troops or 64 paratroopers – or a combination of any of these. **3** Capt Max Mallory (co-pilot), Capt Keri Morris (pilot/safety observer), Lt Col John Kerr (pilot/aircraft commander) and Lt Mike Dzyndra (navigator) during a pre-flight briefing for Kanto 20 at Yokota. **4** The first of 14 C-130Js will arrive at Yokota in October as the process to begin replacing the Hs begins.

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dock is to find naturally occurring defects before they become problems. Problems for the C-130s can range from corrosion and cracks, to tension and hardware checks.

During the inspection, the aircraft is divided into five different sections. Each shop in the ISO dock performs its own speciality inspections on all the different parts of the aircraft. Splitting the aircraft up ensures that nothing is missed and that personnel inspect the entire aircraft.

Lieutenant Colonel Ed Hale, 374th MXS Commander, said of the ISO inspection process: "Yokota has the only C-130 ISO dock in the Pacific region; C-130s from Kadena are also brought here to be inspected. Yokota and Kadena together support more than 20 C-130s. As such, the airmen in the ISO dock play a key role in keeping the Pacific Command's mission going.

"Once all of the inspections are performed, the ISO dock airmen reassemble the planes, check their operability, then send them back mission-ready to their respective units. Aside from ISO Inspection with the legacy C-130H being an older airframe, it requires 9.7 maintenance hours per flying hour, a figure which will drastically reduce when we receive our first C-130J."

> ***"The C-130Hs are truly reliable workhorses and we will be sad to see them go."***
> **Colonel Douglas DeLaMater, 374th AW Commander**

C-130J Transition

The C-130J is coming to Yokota in late 2016. Its increased cargo capacity, power and range will help in disaster relief and other missions across the Pacific. Automated navigation and engineering systems mean the new aircraft needs two fewer crew members. More efficient composite propellers and Rolls-Royce engines provide more power, fuel efficiency and range. The C-130J can fly about 3,000 miles in windless conditions, about the same as the C-130H with external fuel tanks.

AIR International asked Col DeLaMater about the transition process. He said: "The C-130J transition is mostly complete in the US amongst the active duty squadrons, and we've begun our transition here already; every year we participate in a PACAF readiness exercise with the Alaskan Air National Guard operating two C-130Hs and the California Air National Guard operating two C-130Js."

The 36th AS will receive 14 C-130Js over the 18 months after the first is delivered in October,



with the C-130Hs going back to the US for duty in the Air National Guard. Col DeLaMater described the Hs as, "truly reliable workhorses and we will be sad to see them go."

He said: "The C-130H is a pilot's aircraft, stick and rudder control is primary since the avionics are not the most modern, the C-130J is different, far more modern and automated, but the C-130 community has a particular service culture that will endure as we transition. Because the C-130 is a crew served airplane, you develop a tight bond, you succeed or fail together – pilots, navigators, engineers, loadmasters – and that's one of the strengths of the C-130 force. That's something that I believe will only continue to flourish during our operations with the C-130J."

Speaking about the transition, Lt Col Campbell said: "It's important for any unit moving from H to J to preserve the squadron's rich history and tradition. Halfway through the transition, no one will be able to walk down the corridor and say you're a J guy and you're an H guy. Being an Eagle Airlifter is what really matters. Even if we transitioned to C-17s, C-5s, it doesn't matter. We are extremely proud of our mission, and the tools we have to do it only complement that."

Ospreys to Yokota

The Japanese Government formally announced during May 2015 that the US Air Force will deploy a squadron of tilt-rotor CV-22 Osprey aircraft at Yokota in 2017. The first three aircraft will arrive in the second half of the year, and an additional seven are scheduled be stationed there by 2021.

Col DeLaMater said: "The deployment of tilt-rotor aircraft will provide increased capability to respond quickly to crises and contingencies in Japan and across the Indo-Asia Pacific region, including humanitarian crises and natural disasters. It will also increase interoperability, enhance operational cooperation and promote stronger defence relations with Japan's Self-Defense Forces.

"If you look at the geographical location of Japan and the natural disasters which regularly occur in the region, the Osprey will be a huge lifesaving asset; no other platform in existence can perform search and rescue with the range, speed and payload that the Osprey has."

Even though the aircraft will be stationed at Yokota, they will be a geographically separated unit of the 353rd Special Operations Group at Kadena Air Base, Okinawa.

Five of the C-130Hs assigned to the 36th AS, with the 374th AW high-visibility aircraft (74-1655) heading the line.



Sun downers

Dino van Doorn visited VFC-111, a US Navy Reserve adversary squadron based in Key West, Florida



Sundowner 104 and 115 head out to the range.



Boca Chica Field is the original name for Naval Air Station Key West in Florida. The airfield is located on Boca Chica Key approximately 125 miles (200km) south-west of Miami. The base's history goes back to a Naval Base established there in 1823. Naval aviation arrived in September 1917, and the base was officially commissioned by December of that year. Today, Naval Air Station Key West is home to the F-5 Tiger II-equipped Fighter Composite Squadron 111 (VFC-111) 'The Sun Downers'.

It is in close proximity to an airspace complex located over the Gulf of Mexico and the Straits of Florida, comprising operating areas used by squadrons detached to the base for air-to-air training. Aircrew gain valuable information for evaluation and debriefing from the Tactical Aircrew Combat Training System (TACTS). With over 250 days of sunshine annually, Key West offers favourable flying conditions almost all year round.

Establishment of VFC-111

In January 2006, F-5-equipped Fighter Composite Squadron 13 (VFC-13) 'Saints', based at Naval Air Station Fallon established a permanent detachment at Key West. The detachment was redesignated VFC-111 on November 1, 2006 adopting the identity of the former F-14 Tomcat-equipped VF-111 'Sun Downers' based at Naval Air Station Miramar, California decommissioned on March 31, 1995.

VFC-111 is one of only two navy adversary squadrons operating the Northrop F-5 Tiger II that, under the US Navy reserve's fleet adversary programme, provide dissimilar air combat training to fighter squadrons from all branches of the US armed services.

F-5 Tiger II

During the 1970s, the US Navy started operating a small number of F-5 aircraft in the adversary role. When the US Air Force retired its fleet of F-5E and F-5F Tigers in 1990, some of the aircraft were reassigned to US Navy adversary squadrons, but they were old: some near the end of their service life.

In 2004, the US Navy bought 44 F-5 Tiger IIs (39 single-seat F-5Es and five two-seat F-5Fs) from Switzerland, at the time when the Schweizer Luftwaffe was reducing its fleet size due to budget constraints. The former Swiss aircraft, with relatively few hours on the airframe, were delivered to the United States between 2004 and 2007 for overhaul and modernisation by Northrop Grumman at its St Augustine facility in Florida. On April 29, 2009, the recapitalisation programme came to an end with delivery of the 44th and final airframe. Each modernised single-seat aircraft was redesignated F-5N (the two seat jets retained their F-5F designation) and distributed between VFC-13, VFC-111 and Marine Fighter Training Squadron 401 (VMFT-401) 'Snipers' based at Marine Corps Air Station Yuma. The 'Sun Downers' currently operate 17 F-5Ns and one F-5F.

There is a huge demand for adversaries from US Navy, US Marine Corps and US Air Force fighter squadrons but there are insufficient numbers available to cope with the demand. Only about half of the required number of training missions can be fulfilled with fourth-generation adversary aircraft like the F-16 Fighting Falcon and F/A-18 Hornet. The F-5N is used as a substitute and it's very well configured for the role with a sharper nose, different wing leading edge roots and automatic flaps compared to the F-5E.

Pilot Application

There are several steps to becoming an operational VFC-111 adversary pilot. An active duty pilot is selected by the Navy Personnel Command based on a preference list submitted and their end-of-tour fitness report. Full-time support pilots are selected based on a selection board administered by Navy Personnel Command. Reservist pilots apply directly to VFC-111 and are selected based on the squadron's decision.

A full-time pilot contract typically lasts for three years, while reservist pilots, who generally stay with the squadron for longer periods of time, hold active duty on average for one week per month. On average, a VFC-111 pilot flies approximately 200 hours per year in 170 sorties.

All new pilots must have completed at least one fleet tour and flown a minimum of 600 hours on a fighter aircraft, but flying an older third-generation aircraft such as the F-5 requires some adaptations.

Pilot Lt Ryan Pfeiffer said: "On average,

F-5N TIGER II CHARACTERISTICS

Length: *47ft 5in (14.45m)*

Height: *13ft 4in (4.06m)*

Wingspan: *26ft 8in (8.13m)*

Max design take-off weight: *24,722lb (11,214kg)*

Max design zero fuel weight: *9,723lb (4,410kg)*

Power plant: *Two General Electric J85-GE-21C turbojet engines each rated at 5,000lb (22.41kN) of thrust.*

Airspeed at 36,000ft: *Mach 1.64*

Ceiling: *50,000+ft (15,420m)*

Maximum Range: *2,314 nautical miles (4,286km)*

Armament: *One AIM-9 Sidewinder and one P5 CTS/TCTS pod each mounted on a wing-tip missile launcher rail*

Inventory: *F-5N 41 (US Navy 30, US Marine Corps 11); F-5F 3 (US Navy 2, US Marine Corps 1)*



1 Pilots assigned to VFC-111 fly an average of 200 hours per year. **2** VFC-111's Sun Downers nickname originates from Fighter Squadron 11 (VF-11) and refers to the unit's mission to shoot down Japanese fighters or suns during World War Two. **3** With over 250 days of sunshine each year, Naval Air Station Key West offers favourable flying conditions almost year round. **4** F-5N BuNo 761562 seen at Key West without VFC-111 markings. The aircraft had recently returned from its annual phase inspection undertaken by Northrop Grumman at its St Augustine facility in Florida. Maintenance at Key West is performed by Sikorsky Aircraft Corporation.

about ten flights in the F-5F is sufficient to teach and train a new pilot the basics of flying the aircraft: the real challenge starts at that point."

Each pilot must gain their adversary qualifications. There are four levels: solo adversary; wingman in a two-ship flight; lead of a division flight of four aircraft; and lead of a flight comprising more than four aircraft.

Meeting Customer Needs

US naval aviation requires adversaries with different capabilities for a range of training events, as Lt Pfeiffer explained: "VFC-111 is well trained and up to the broad range of complex missions its customers continuously ask for. Missions range from a single event with one F-5 to those that require multiple adversary aircraft for practising different scenarios."

The vast majority of adversary support provided is directly related to maintaining readiness of fleet strike fighter squadrons under the Fleet Response Training Plan (FRTP); an extensive syllabus for ensuring naval forces are prepared and ready for their different roles. VFC-111 facilitates two FRTP events: primarily, the Fighter Weapons and Tactics (FWT) phase of the training courses run by Super Hornet and Growler Fleet Replacement Squadrons, and the Strike Fighter Advanced Readiness Program (SFARP). For example, detachments of Super Hornets assigned to Strike Fighter Squadron 106 (VFA-106) 'Gladiators' from Naval Air Station Oceana, Virginia, and VFA-122 'Eagles' from Naval Air Station Lemoore, California, are almost permanently at Key West. The FWT phase is a training event that each trainee pilot must complete before joining a fleet squadron and is always conducted at Key West.

Unlike FWT, which is conducted for pilots learning to fly the Super Hornet, SFARP is a squadron-level training event undertaken by each fleet squadron as part of its work-up prior to deployment with a Carrier Air Wing embarked on a carrier, and lasts for up to four weeks. During an SFARP period, pilots train against adversary pilots to hone their tactics and procedures in different roles within scenarios that are as near to real life







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as possible: ones that become increasingly complex and end with a certification event.

The FWT phases and SFARP periods account for 37% of the annual demand for adversary aircraft, placing VFC-111 and its sister squadron VFC-13 at the heart of the training requirements for the US Navy's Carrier Air Wings, which undertake deployments around the world on a continuous basis.

Out on the Range

Most missions are flown in the Key West complex located in the Gulf of Mexico and the Straits of Florida off the shores of Cuba. Within minutes of take-off, aircraft are in airspace over the vast Key West complex. Depending on the mission's duration, pilots proceed to different instrumented ranges, instrumented target areas or non-instrumented warning areas such as W-174. The entire W-174 area is covered by a TACTS and is almost entirely devoted to dissimilar air combat training.

Real-time tracking of aircraft engaged in air combat is provided by the TACTS, which has a replay function to help assess each aerial duel with aircraft positional data and the outcome of each missile shot.

Naval Air Station Key West was the first navy installation to receive the P5 Combat Training System/Tactical Combat Training System (CTS/TCTS) in 2006. The system, developed by Cubic Defense Applications, allows interoperability with US Air Force and ally units that use the P5 system, and has proved to be an invaluable asset for VFC-111. Lt Pfeiffer said the P5 system, in combination with the P5 instrumented pod, offers very detailed insight of the performance of the individual strike fighter aircrew: "It allows for a steep learning curve during the time they have here to train with our squadron. It also provides adversary pilots with valuable information; allowing us to continuously improve tactics and skill."

The pod is mounted to a missile launch rail in place of an AIM-9 Sidewinder or AIM-120 AMRAAM, which allows it to be used by a variety of fixed-wing and rotary-wing aircraft. The GPS-based pod provides precise, continuous tracking of each aircraft involved in the mission and collects a diverse cache of in-flight data, including real-time kill notification to the aircrew and real-time weapon scoring for long-range weapon shots.

A P5 pod can support up to 100 aircraft in a single exercise, has a range of 80 nautical miles (150km) in an air-to-air scenario and 125 nautical miles (230km) in an air-to-ground mission. The latter can be extended to over 200 nautical miles (370km) with some minor modifications.

Data is downloaded to the ground stations in real time, such that when all players have safely returned to Key West all mission data will be ready for the debriefs.





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1 The high demand for adversary training combined with a low operating cost base means VFC-111 is likely to continue operating the F-5N until 2020. **2** An F-5N returns to the VFC-111 ramp after a mission against F/A-18 Super Hornets from Strike Fighter Squadron 122 (VFA-122) 'Eagles' based at Naval Air Station Lemoore in California. **3** P5 air combat manoeuvring pods are mounted on a wingtip rail to capture positional and flight data during all aerial duels flown in the Key West range. **4** VFC-111's aircraft are painted in different colour schemes; just one aspect of the squadron's adversary mission. Each colour scheme is designed to replicate different types of potential enemy fighter aircraft.

TIGER II HISTORY

The Northrop F-5N Tiger is the latest variant of the agile, highly manoeuvrable, reliable and supersonic fighter jet: the backbone of the US Navy's adversary fleet for years.

The F-5 is a third-generation aircraft developed by Northrop (now Northrop Grumman) in the early 1960s as an exportable fighter jet available through the US Military Assistance Program.

The F-5 was designed as a low-cost, lightweight, multi-role Mach 1 capable fighter aircraft, which proved popular on the export market with 26 different countries. More than 2,600 were built by Northrop and under co-production and licensing agreements with Canada, the Republic of China, the Republic of Korea, Spain and Switzerland.

Optimised for the air-to-ground role, the F-5A had a very limited air-to-air capability. However, in December 1970, a new version was designed and developed to offer more manoeuvrability rather than speed, featuring a greater wing area and improved leading-edge extensions.

Avionics were upgraded with the Emerson Electric AN/APQ-153 series radar. The aircraft received more powerful engines and a more fuel capacity. The first flight of the improved F-5 took place on August 11, 1972 designated the F-5E Tiger II.

The US Navy's current F-5N is a much upgraded version of the E-model, completely rewired with a new gaseous oxygen generating system to reduce operating costs. The F-5N also features a new inertial navigation system; a new display with a multifunction touchscreen capability; embedded GPS; a new fibre optic gyro; ALR-87 radar warning receivers; ALE-40 chaff and flare system; and an anti-skid braking system.



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Requirements

Fleet demand for adversary training currently exceeds the sortie capacity of the Adversary Air Force. With a rapidly ageing fleet of F-5s, F/A-18s and F-16s, the US Department of Defense is looking for solutions to meet its short-term and medium-term needs.

One solution is to contract private companies to provide additional adversary support in terms of the number of available aircraft and hours. So-called contracted air services have proven to be successful for several years, with two major companies currently offering such a service: ATAC based in Newport News, Virginia, and Draken International from Lakeland, Florida.

Each company has a variety of aircraft in operation ranging from Hunter Mk58s to A-4 Skyhawks. Most of the company pilots are former navy or air force adversary pilots with thousands of hours of flight time and experience to match. Their respective aircraft are a common sight at Naval Air Station Key West.

Because of the F-5's lower cost base to maintain and fly, it is no surprise that the Department of Defense is considering options to increase its F-5 fleet to increase the capacity in the short term and replace the existing fleet with low-hour examples at a later stage. Lt Pfeiffer said: "With the number of F-5 sorties we are flying at VFC-111, it is estimated the aircraft will only last until 2020. It would be great if we could extend the fleet with fresh aircraft and be able to continue using the type beyond 2020. However, future plans are not solid yet."

In the past, talks took place with the Swiss Government to buy another batch of F-5Es, which will become redundant due to further downsizing of the Schweizer Luftwaffe. Following a public referendum on May 18, 2014, the Swiss public voted against procurement of 22 JAS 39E Gripens. As a result of the referendum, a new fighter procurement programme will start next year. This may well reopen the doors for further negotiations with the US Government to buy the remaining F-5s in service with the Schweizer Luftwaffe before 2020. A positive conclusion to future negotiations would ensure an assured future for VFC-111.



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Success Y



This belly view shows two clusters of Ataka anti-tank guided missiles and two B8V-20A rocket pods under the wing, a single-barrel 30mm 2A42-2 cannon and a round OPS-28 electo-optical turret in the nose. A box with two round antennas at the root of the tail beam contains DISS-32-28 Doppler radar. *All photos Piotr Butowski*

Almost 40 years ago, on December 16, 1976, the Soviet Government ordered the Mil design team to create a new-generation combat helicopter, equivalent to the American AH-64 Apache. Six years were enough to make the Mi-28 design and prototype.

However, tests of the helicopter fell away during the crisis at the end of the USSR and the unstable 1990s. Only in 2008 did deliveries of production Mi-28N helicopters to the Russian Air Force begin. The first foreign customer, Iraq, got the first batch in 2014. About 100 helicopters have been produced.

History

Unlike the earlier Mi-24, the Mi-28 was to be a specialised anti-tank and anti-helicopter weapon without a cargo cabin, but with improved manoeuvrability and climb rate, better survivability, and expanded armament and systems. The first design that reached the level of a full-scale mock-up, numbered 01, was a helicopter featuring a transverse rotor layout with two 10.3m (33ft 9in) diameter lifting rotors side-by-side and a pusher propeller in the back. The helicopter's weight was 11,500kg (25,353lb) and its two TV3-117F engines, each generating 2,800shp (1,491kW), provided a 205kts to 226kts (380-420km/h) speed. Another mock-up, 02, looked

ears Later

Piotr Butowski profiles the Mi-28 and assesses its potential



MI-28N HAVOV CHARACTERISTICS

Crew: *Two in tandem, with the weapons system officer/navigator in the forward cockpit and the pilot at the rear. The Zvezda/Tomilino Pamir-K crew seats have belts that tighten automatically at high g loading*

Powerplant: *Two Klimov VK-2500 turboshaft engines, each rated at 2,200shp (1,641kW). An AI-9V APU is located between the engines at the tailboom root. Maximum internal fuel capacity is 1,300kg (2,868lb) in three self-sealing polyurethane foam filled tanks, with self-tightening latex protectors. An optional four underwing auxiliary tanks can increase total capacity to 3,059kg (6,744lb)*

Dimensions: *Main rotor diameter 17.2m (56ft 5in); tail rotor diameter 3.84m (12ft 7in); maximum length with rotors turning 21.15m (69ft 5in); fuselage length 16.88m (55ft 4in); length without rotors up to nose gun tip 17.01m (55ft 10in); maximum height 3.82m (12ft 6in) to top of rotor head without radar; wingspan 4.88m (16ft); width with APU-8-4U clusters attached 5.82m (19ft 1in); wheelbase 11m (36ft 1in); wheel track 2.29m (7ft 6in)*

Weights: *Empty 8,550kg (18,850lb), without self-defence suite; nominal take-off 11,000kg (24,250lb) with eight Ataka missiles and gun ammunition; maximum take-off 12,100kg (26,676lb) with 16 Ataka missiles, two B-13L1 rocket launchers and gun ammunition*

Performance: *Maximum speed 151kts (280km/h); cruising speed 120kts (240km/h) at nominal take-off weight (TOW) or 118kts (220km/h) at maximum TOW; OGE hovering ceiling 2,950m (9,678ft) at nominal TOW or 1,420m (4,659ft) at maximum TOW; service ceiling 16,400ft (5,000m) at nominal TOW or 14,750ft (4,500m) at maximum TOW; combat radius 155km (83nm) at nominal TOW or 140km (75nm) at maximum TOW with 5% reserve*



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like a slimmed down Mi-24 with the troop compartment removed. This design became a basis for further work.

The preliminary design of the Mi-28 (izdeliye 280; NATO codename Havoc) was approved in June 1981. On November 10, 1982, Gurgen Karapetyan and Viktor Tsigankov flew the initial prototype, numbered 012, for the first time. The same crew made a first flight circuit on December 19, 1982. The helicopter was not equipped with targeting and some other systems and was used only for basic flying tests. On May 6, 1993, Karapetyan and S Siregin performed looping for the first time and several days later a roll with 012. The second Mi-28, 022, intended for armament tests, had a movable optical sight turret and large nose antenna for the radio datalink used to control anti-tank missiles. Small windows next to the turret were intended for infrared night observation systems. However, these have never been installed on the helicopter. The first information about the Mi-28 was published in 1984 in the annual US Department of Defense Soviet Military Power report. A year later, the same report published a drawing of the helicopter.

The first hovering flight of the Mi-28A (izdeliye 286) took place on January 7, 1988, and its first circuit 12 days later. This helicopter, 032, featured a new X-type tail rotor, redesigned engine exhausts, improved sensors and flare launchers in oval fairings at the wing tips for self-defence. The second Mi-28A, 042, was only slightly different; it lacked the above-mentioned small windows for night observation systems.

In the 1980s, the Mi-28 lost several comparison test series with the Ka-50 Hokum. In October 1984, the armed forces chose the Ka-50 and ordered series production to start in Arsenyev. Nevertheless, in December 1987, a decision was made to start parallel series production of the Mi-28 in Rostov-on-Don. However, due to a lack of money, only a small batch of Ka-50s was made at the beginning of 1990s and production of Mi-28s did not start at all.

Mi-28N

On September 30, 1991, the Russian Ministry of Defence ordered from the Mil design bureau the Avangard-2, a night version of the Mi-28 (at the same time, Kamov was ordered to undertake Avangard-1, a night version of the Ka-50). Mil abandoned the Mi-28A and concentrated all efforts on the night-capable Mi-28N (izdeliye 294; NATO codename Havoc-B). However, financing for the programme was scarce and development was very slow.

The first Mi-28N prototype OP-1 (014) made a first hovering flight on November 14, 1996, piloted by Vladimir Yudin and S Nikulin; the same crew undertook a first flight circuit on April 26, 1997. The first Mi-28N made only a few flights before the programme was stopped for several years in expectance of new systems and, particularly, a new main transmission gear. Only on April 24, 2002 did 014 resume testing with the VR-29 transmission (instead of the former VR-28) adapted for higher power. The same year, the helicopter proceeded to state acceptance trials.

The second test Mi-28N, OP-2 (024), was



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built by the Rostvertol production plant and made its maiden flight on March 25, 2004. This had new main rotor blades, a control plate and rotor head, as well as improved controls for the engine and fuel system. The first stage of the state acceptance trial was successfully accomplished on March 4, 2006; this formally gave the right to manufacture an initial batch of helicopters for military tests.

By summer 2007, the Rostvertol plant had completed seven pre-series production helicopters (numbers 32 to 38) for further tests by Mil and the military (the first, 32, made its initial flight on December 27, 2005). The second stage of the state evaluation concluded on December 26, 2008, allowing deliveries to operational units. The helicopter was officially commissioned by presidential order on October 15, 2009, repeated by the Ministry of Defence's directive of November 22, 2013, after correction of shortcomings revealed during the tests. For some time, an intermediate Mi-28D (Dnevnoi, daytime) version was considered, using the Mi-28N's airframe, power plant, rotors and transmission, but still without night sensors.

After five prototypes (two Mi-28s, two Mi-28As and one Mi-28N) were completed by the Mil design bureau's workshops, all the subsequent Mi-28Ns have been and continue to be built by Rostvertol. The company's Rostov factory is now manufacturing the

1 The OPS-28 Tor electro-optical turret is the Mi-28N's main search and targeting sensor. A ball for the pilot's TOES-521 turret is fitted above. Two blisters at the sides are sensors for the L150-28 radr warning receiver. **2** Optionally, the helicopter takes four 9M39 Igla-V anti-aircraft tube-launched missiles to counter enemy helicopters. Note also the engine nacelle in the background, with an inlet dust filter and a fixed heat dissipater at the engine exhaust. **3** A cluster of eight 9M120 Ataka-VN anti-tank guided missiles on an outer underwing pylon is a standard weapon. **4** The Mi-28N operator's (front) cockpit has two MFI-10-6M displays arranged vertically, a PS-7V control panel on the right and a basic set of analogue instruments on the left. **5** By 2020 Mi-28N will be the most widespread combat helicopter in service with the Russian armed forces. **6** The first Mi-28UB '37' combat trainer converted from Mi-28N c/n 02-01 at the Rostvertol factory. In April 2016 the Russian Ministry of Defence ordered 24 such helicopters to be delivered by 2018.

helicopters at a rate of about 15 per year. As of mid-2016, about 105 had been completed.

The supply of engines and some other components supplied by companies in Ukraine (for example, the I-256 datalink for the Ataka missile is made by Lorta in Lviv) has been disrupted by the political turmoil between the two nations; the production of VK-2500 engines in St Petersburg, Russia used Ukrainian components. The Russians have declared they can quickly start the full production cycle of helicopter engines at home. For example, engines for the Mi-28 (and for most other Russian military helicopters, including the Mi-8 and Ka-52) were instead delivered by Motor Sich from Zaporizhia. Nevertheless, there is no data about the actual results of the programme to substitute the imports.



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Russian MoD Orders

The Russian Ministry of Defence has placed a series of orders for the Mi-28N, for a total of 191 examples. In 2015, 67 helicopters were ordered, following 30 in 2010 and 70 in 2011. The most recent contract, placed in April 2016, is for 24 helicopters in the new Mi-28UB configuration. On January 22, 2008, the Russian Air Force accepted delivery of the first two Mi-28Ns (numbers 41 and 42) in Rostov-on-Don; these were later delivered to the 344th Evaluation and Operational Conversion Centre in Torzhok. Successive deliveries were made to there, and then to operational air bases at Budionnovsk (387th Air Base; from March 2009), Korenovsk (393rd Air Base, October 2010), Rostov-on-Don



1 This helicopter, '03', was one of the first operational Mi-28Ns. Note the NPPU-280-1 nose turret with flexible single-barrel 30mm 2A42-2 cannon and 250 rounds in side magazines. The I-256 radio-command guidance datalink for the Ataka missile is fitted in the nose tip. **2** The mast-tip GRPZ/ Ryazan N025 single-range millimetre-wave radar, mounted on the main rotor mast, seen here on '36' which between December 2011 and April 2013 conducted evaluations of the radar, will be installed in new Mi-28Ns and retrofitted on those in service. **3** A Mi-28N undergoing final equipping, almost ready to leavethe hall at the Rostvertol plant in Rostov-on-Don.

(546th Air Base, now 16th Army Aviation Brigade; summer 2012), Ostrov (15th Army Aviation Brigade; August 2013) and Vyazma (378th Air Base; 2014).

Colonel Viktor Bondarev, Commander-in-Chief of the Russian Air Force, said in 2013 that before 2020 the air force would receive 40-60 helicopters in a training version with, "four to six for each military unit operating Mi-28 helicopters". This suggests the Russian objective is to field ten air bases (regiments) equipped with Mi-28s. The Russians are using Mi-28Ns in Syria now; the type was deployed there in March 2016.

The Mi-28UB (izdeliye 298) trainer version prototype '37' converted from Mi-28N serial number 02-01, was flown in mid-July 2013 in Rostov-on-Don, piloted by Sergey Barkov and G Ananyev. The front cockpit of the Mi-28UB is equipped with the controls, artificial horizon and horizontal situation indicator. The pilot and student (operator) have new shock-absorbing AK-2005 seats instead of the former Pamir-type seats. The width of the Mi-28UB's crew compartment is increased by 140mm (5.5in). The Mi-28UB retains all the mission systems of the Mi-28N.

Overseas

The foreign debut of the Mi-28 took place at Paris Le Bourget in June 1989 where Mi-28A 032 was shown; later, Mi-28A 042 was shown at Le Bourget in 1993 and Mi-28N 014 in 1997. However, no customer was found. An agreement had been signed with Iraq in 1990 for the delivery of the Mi-28 and subsequent manufacture of licensed Mi-28Ls there, but that was later abandoned. In October 1995, a Mi-28A (042) was tested in Sweden (along with the AH-64 Apache. The Swedes intended to purchase 20 assault helicopters, but they gave up this transaction for financial reasons.

A first export contract was concluded in 2012-2013 when Iraq ordered 15 Mi-28NEs (izdeliye 299); the first three of these were delivered on August 28, 2014. The next two were delivered in February 2015 and spotted over Baghdad in March that year with mast-mounted radars – these are the first operational Mi-28s with radars. On December 26, 2013, Algeria ordered 42 Mi-28NEs in a customised configuration with dual controls and the N025E radar, similar to the Russian Mi-28UB (Mi-28N 32 had passed intensive

tests in Algeria back in 2007).

There are other countries interested, including Brazil, Egypt, Peru and Venezuela, as well as Kazakhstan, Turkmenistan and Uzbekistan among the former Soviet republics. The Mi-28NE took part in the tender for 22 attack helicopters for India, but lost to the AH-64.

Combat Capability

The Mi-28N's weapons are carried on four underwing pylons. The standard anti-tank configuration comprises eight (or a maximum of 16) 9M120 Ataka-VN anti-tank guided missiles in one (or two with 16 missiles) eight-tube APU-8/4U clusters; the missile reaches a range of 6,000m (19,685ft) at supersonic speed. Other weapons include up to four B-13L1 (122mm/4.80in) or B-8V-20A (20 80mm/3.1in) rocket pods, KMGU submunition dispensers, mine-laying containers, UPK-23 and GUV gun packs, and others. The 9M39 Igla-V anti-aircraft tube-launched missile can be used against enemy helicopters. A single-barrel 30mm 2A42-2 cannon with 250 rounds is mounted in the NPPU-280-1 (9A-4349-1) under-nose turret that can be moved +/-110° in azimuth, and +13/-40° in elevation.

The Mi-28N's avionics are integrated into the BREO-28 (izdeliye 930) suite developed by Ramenskoye RPKB. The system is controlled by two Baget-53-015 computers and combines targeting sensors, navigation, communication and self-defence systems, a data presentation system, and the SUO-280N-01 weapons management system.

The Ataka-VN anti-tank guided missile system includes the Zenith/Krasnogorsk OPS-28 Tor (path) electro-optical search/targeting turret with TV and forward-looking infrared channels (each wide and narrow), a LD-294 laser rangefinder, and an I-256 radio-command guidance datalink for the Ataka missile fitted in the nose tip. The OPS-28 is located in a rotating turret under the helicopter's nose; it covers +/-110° in azimuth and +30/-45° in elevation. Its search range for a tank-type target is 7km (3.7nm), while aiming range is 5km (2.7nm). Another electro-optical turret is the pilot's UOMZ/Yekaterinburg TOES-521 in a ball in front of and above the OPS-28.

Currently, the OPS-28 is the only targeting sensor found on Russian operational helicopters, since the radar has not yet been installed. The GRPZ/Ryazan N025 is a single-range millimetre-wave (Ka-band) radar



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for surface mapping, detection of surface targets, and indication of targets for the more precise electro-optical sight and directly for the weapons. The radar is installed at the top of helicopter's main rotor mast. From December 2011 to May 2012, Mi-28N 36 made 12 flights with the N025 radar to test the mechanical joints. Then, from October 2012 to April 2013, 28 flights were conducted to evaluate radar performance, including detection range of various targets and accuracy of the target coordinates. After completion of state acceptance tests, N025 radars will be installed on new Mi-28Ns and retrofitted into those already operated by the Russian Air Force as they return to Rostvertol for periodic repairs. The first production Mi-28NEs with the radar were flown at Rostov-on-Don at the end of 2014 and were delivered to Iraq in February 2015 (official Russian Air Force certification is not required for the export version).

The flight/navigation system comprises PKV-M24A autopilot, SVS-V28 air data system, SVVD-28 air pressure receiver, INS-2000-02 (Ts-094) inertial navigation, A-737-011 satellite navigation receiver, DISS-32-28 Doppler radar, ARK-25 direction finder, A-052 radio altimeter, and other items. The data presentation subsystem utilises two MFI-10-6M displays in each cockpit, an ILS-28M heads-up display for the pilot and a PS-7V control panel for the operator. The crew have night vision goggles. The KSS-28N-1 communications suite comprises two R-999 UHF radios, a Prima high-frequency radio, a T-921 encrypted communication system, and others.

In current operational helicopters, self-protection features comprise the L150-28 Pastel radar warning receiver, L140 Otklik laser warning receiver and two 32-tube UV-26 flare dispensers in the wingtip fairings. The 1L229 identification friend or foe is also incorporated. An advanced configuration presented at the MAKS 2015 air show includes new wingtip pods with additional L370-2 UV missile launch and approach sensors and a directional infrared countermeasures head under the fuselage. A total of 350kg (772lb) of armour protects the cockpit and engine bays. The cockpit is armoured with titanium and ceramic plates, and bullet-resistant flat plate glazing; it can withstand direct hits from 7.62mm (0.3in) and 12.7mm (0.5in) calibre machine gun rounds, or fragments from 20mm cannon shells. The front transparency has glass 50mm (2in) thick; the side windows are 35mm (1.4in) thick.

Further Developments

When the basic Mi-28N was accepted in 2009, the Avangard-3 programme was launched to produce the Mi-28NM (izdeliye 296). This helicopter will receive the new BREO-28M (izdeliye 930M) avionics suite developed within the Arbat programme, including the BRLK-28 radar system with N025M radar, OPS-28M Tor-M electro-optical turret (the GOES-451M of the Ka-52 was considered, but rejected) and upgraded SUO-280NM stores management system. A new LSN-296 laser missile homing system (instead of the Mi-28N's LD-294 laser rangefinder) will enable employment of new versions of the Ataka and Khrizantema anti-tank guided missiles switch combined radar and laser beam guidance, as well as the new LMUR guided missile. The crew will receive NSTsI-V helmet-mounted sight and display systems. A new self-defence suite is also being developed. The platform changes will be minor, except for installation of new VK-2500P engines with improved 'hot and high' capability, presently under development by Klimov in St Petersburg, as well as a new TA14-130-28 APU provided by Aerosila. The prototype of the Mi-28NM will be converted from Mi-28N serial number 02-02, '38'. The Mi-28EM will be the export derivative of the Mi-28NM.


3

Emergency



Members of the 9th CST set up their equipment inside the helicopter in transit to the intercept of the boat. A laptop tied into the equipment the team uses to detect radiological and biological threats shows readings of what and how much of those threats exist in the nearby area.
All photos Scott Dworkin

Response

Scott Dworkin reports from California on a key public safety exercise involving the Air National Guard

Between April 25 and 28, local and federal agencies participated in a Regional Maritime Public Safety Exercise in various locations in and around San Diego, California to practise trained responses to potential maritime terrorist threats. These exercises are used to practise techniques necessary in the case of international drug trafficking, radiological material in the water, foreign fighter threats and other suspicious activity attempting to enter the United States via the maritime environment.

Agencies involved during this large exercise were the San Diego Fire and Rescue Department, including the department's hazardous materials (HAZMAT) teams, San Diego Police Department, San Diego County Lifeguards, San Diego Harbor Police, United States Customs and Border Patrol, the Federal Bureau of Investigations (FBI), California Fish and Game, and the US Coast Guard.

Additionally, the California National Guard participated with the 129th Rescue Wing HH-60G Pave Hawk helicopter, and the 9th Civil Support Team (CST). The exercise consisted of three separate operations. Maritime law enforcement and first responders conducted small and large vessel radiological screenings at various locations in and around San Diego Bay and Mission Bay.

The Location

San Diego was selected for the exercise, which has taken place



annually since 2010, because of its proximity to the US-Mexico international border, the presence of the largest naval base on the west coast and other major military bases, its high population density, the ease of access and proximity to the city by small waterborne vessels, and the large number of vessels using local San Diego waterways.

The Joint Forces Training Base Los Alamitos, California-based 9th CST team, comprising 22 soldiers and airmen, are trained to identify chemical, biological, radiological and nuclear agents and to help on-scene commanders project the consequences of an event, advise on response measures and assist with requests for state and federal support. (There is also a second CST team, the 95th CST, based in Hayward, California.) During a real-world event, the CST team can be deployed anywhere in the country to a suspected or known WMD incident to support civil authorities at a chemical, biological, radiological, nuclear and high-yield explosives (CBRNE) incident.

Civil Support Team Duties

During the exercise, 9th CST members were on board the 129th Pave Hawk helicopters and various vessels on the water carrying specialised hand-held equipment that can rapidly analyse industrial-type, low-level radiation sources placed on vessels as part of the exercise and other types of chemical and biological agents, and then give analysis to predict the dispersion of HAZMAT based on terrain and weather.

The 9th CST also provides medical expertise and treatment information to the other local agencies that participated. It can bring a self-sustained decontamination facility for entry-team members and a state-of-the-art mobile communications system. The CST demonstrated during this Maritime Public Safety Exercise the ability to coordinate quickly with local San Diego emergency first responders.

In a real-world scenario, the first





1 A HH-60G from the 129th Rescue Wing orbits over San Diego Bay during the exercise involving an attempted terrorist takeover of a ship at sea. **2** The Pave Hawk aggressively turns in pursuit of the suspected terrorist vessel. As the 129th is from Northern California, and not entirely familiar with flying in the San Diego area on a regular basis, flying to and from the targets quickly was a major part of the exercise along with identifying and classifying the threats. **3** The exercise utilised local tourist vessels to simulate a larger cruise ship. Here a US Customs and Border Patrol HH-60 comes into a low hover over the simulated hijacked ship to set up for a fast rope insertion of a strike team. **4** A pilot from the 129th conducts a pre-flight inspection of the Pave Hawk prior to the afternoon launch. **5** First responders conducted radiological screenings of both large and small vessels. Here the HH-60 conducts a low-level flyover of the local vessel used as the simulated intercept target off the San Diego coastline. **6** The California ANG HH-60 staged out of nearby San Diego International Airport during the exercise. In this photo the team from the 9th CST prepares to load their specialised equipment onboard the aircraft.

responders to a WMD event would typically be the local agencies, so a part of the CST's regular training is to ensure that when called upon the team can be quickly and fully be integrated into the National Incident Management System (NIMS). Typically, a local Incident Commander will respond to an event using available resources; should a shortfall in response capability be identified, the Incident Commander will request CST support from the Governor's Office of Emergency Services.

Pave Hawk

The HH-60G Pave Hawk helicopter sent to participate in the exercise came from the 129th Rescue Squadron (129th RQS), a unit of the California Air National Guard's 129th Rescue Wing stationed at Moffett Federal Airfield in Mountain View, California. During the event, while staging out of nearby San Diego International Airport, the Pave Hawk quickly transported the 9th CST team around the area to selected targets and, while orbiting over the vessel, the team could evaluate from the air whether the targets were indeed carrying any radioactive materials.

The primary mission of the 129th is to conduct day or night combat search and rescue operations into hostile environments to recover downed aircrew or other isolated personnel during war, but because of its versatility the HH-60G is also tasked to perform other military operations, including



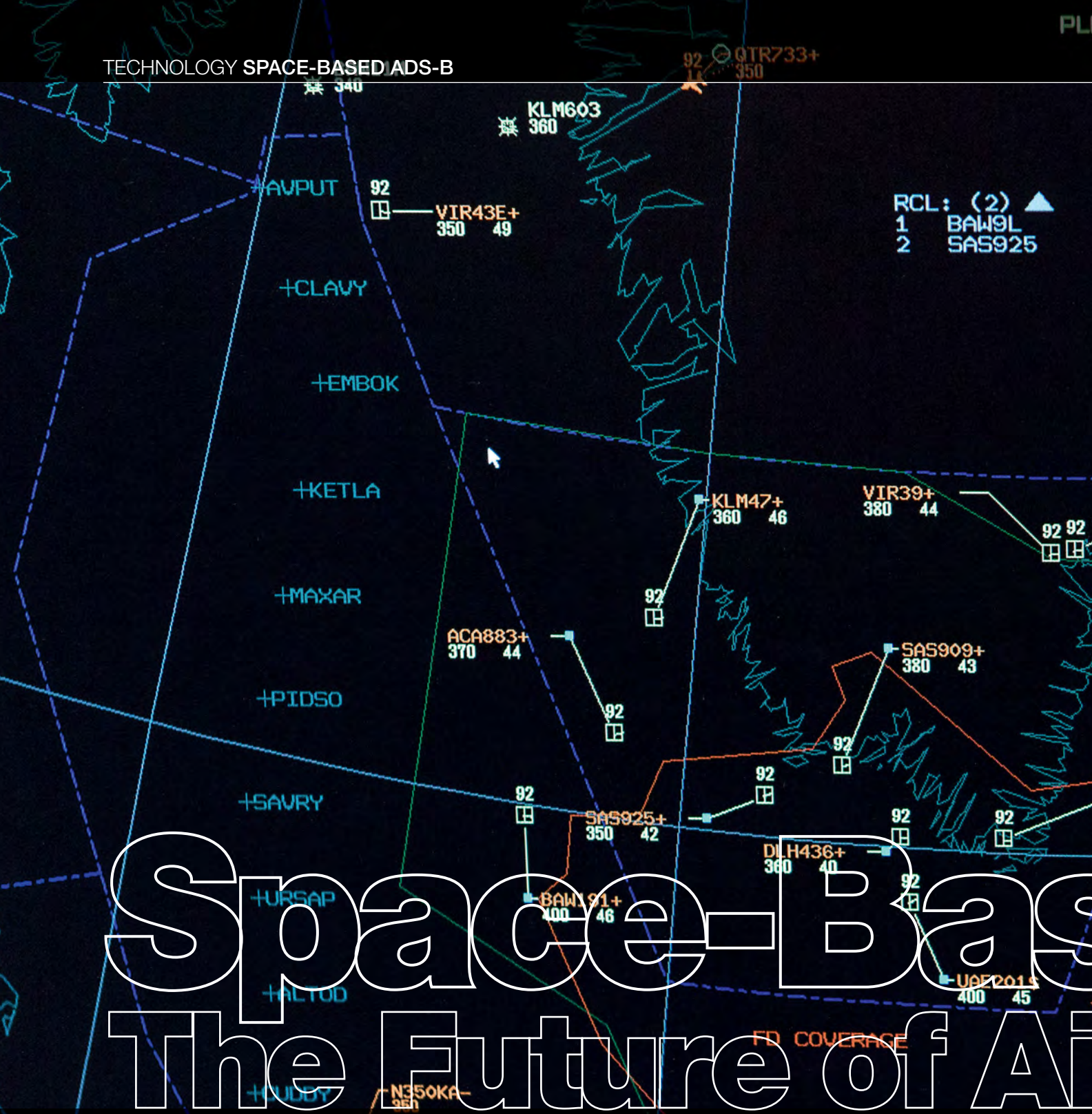
civil search and rescue, emergency aeromedical evacuation, disaster relief, international aid and counterdrug activities. This exercise was a demonstration of the HH-60's flexibility and the wing's ability to respond to such a potential disaster scenario.

While spokespeople during the exercise stressed that no known current threat exists to San Diego or any other US port, the





exercise provided agencies with a chance to conduct operations under realistic conditions. The four-day exercise also allowed for the multiple agencies to work as one team to understand better how effective and prepared they currently are, should a maritime threat ever arise, and through the training develop better communication and response strategies for any future potential threat scenarios.



Space-Based ADS-B: The Future of Air Traffic Control

Chris Kjelgaard looks at why a new constellation of low-Earth orbit

Over a period of 18 months from February 2018, although airline passengers generally won't be aware of it, air traffic control in the world's busiest oceanic airspace and huge volumes of remote territorial airspace in Africa and elsewhere will be revolutionised.

Today, primary and secondary (transponder-interrogating) radar and GPS-reliant ground-based Automatic Dependent Surveillance – Broadcast (ADS-B) air traffic surveillance technologies can't reliably detect aircraft in flight at ranges beyond 250 nautical miles (460km). Broadcasting signals from and receiving them at facilities on the ground, radars and ground-based ADS-B receivers can only detect aircraft in their line of sight – which for an airliner flying at cruising altitudes of 31,000ft (9,450m) to 43,000ft (13,105m) is from 200nm to 250nm (370km-460km).

For each of the 440,000 flights routing westbound or eastbound through the Shanwick and Gander flight information regions (FIRs) across the North Atlantic between Europe (and the Middle East) and North America annually, this means that once the flight travels beyond 250nm from land, today's air traffic management (ATM) surveillance equipment can't detect it. Air traffic controllers managing these transatlantic flights have to rely on procedural methods of control to ensure that aircraft travelling on the same routes at the same altitudes remain far enough apart to ensure safety of flight. Mutually, the Gander and Shanwick FIRs handle about 80% of all air traffic crossing the North Atlantic and together they represent the world's busiest oceanic airspace.

This ATC screen showing part of Nav Canada's Gander fllght information region. *Nav Canada*

sed ADS-B
r Traffic Control

satellites will profoundly influence air traffic control all over the world

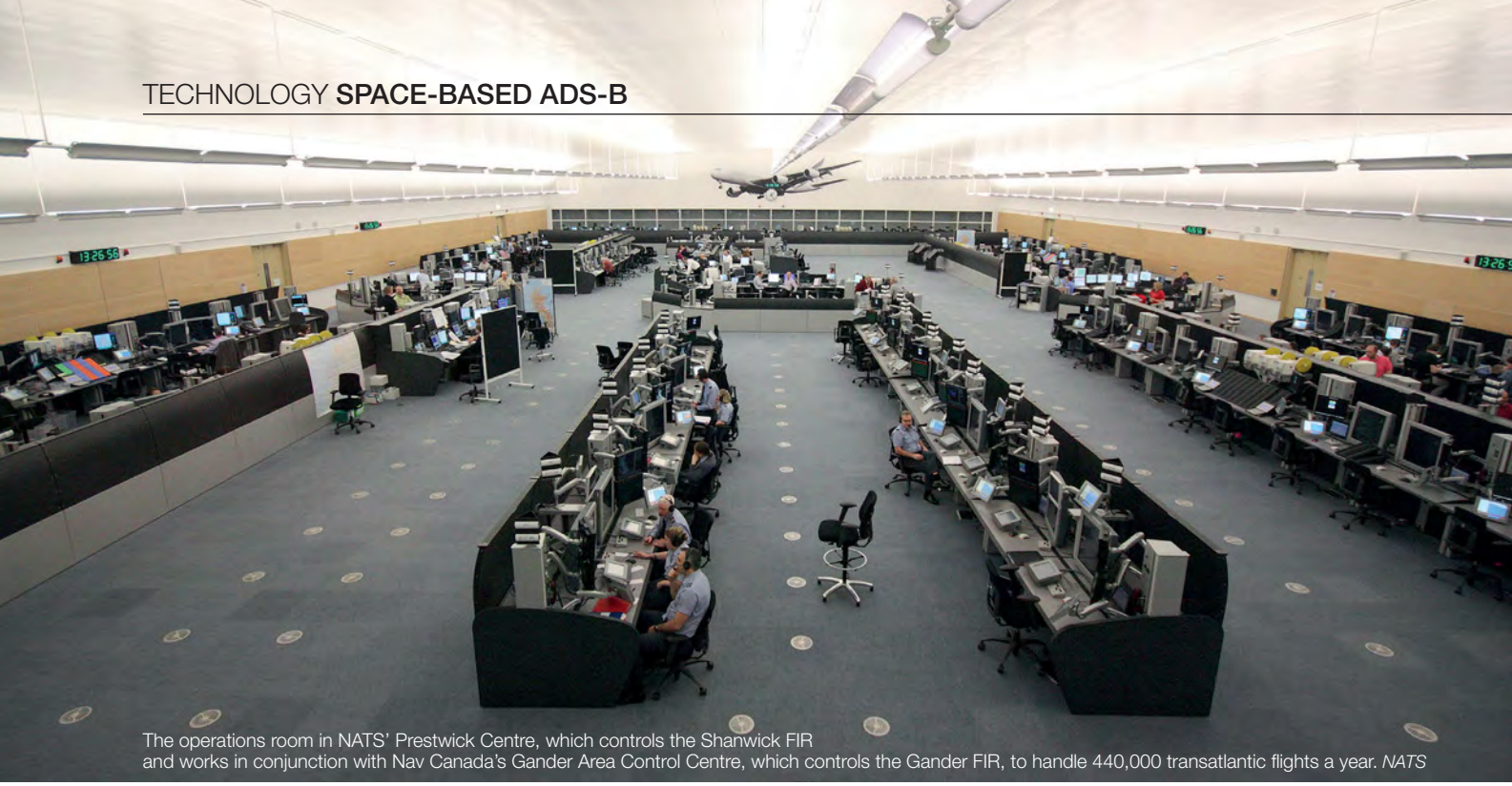
Procedural Control in North Atlantic Airspace

The procedures used for controlling North Atlantic transatlantic flights rely on aircraft maintaining specific altitudes, routings and indicated airspeeds (measured as exact percentages of Mach). Today, about 90% of civil aircraft crossing the North Atlantic at upper-airspace cruising altitudes are equipped with GPS and other navigation systems that can fly them precisely along the required three-dimensional trajectories required for the crossing.

Air traffic controllers at the UK's National Air Traffic Services (NATS) Prestwick Centre, which controls the vast Shanwick FIR, and at Nav Canada's Gander North Atlantic Oceanic Control Centre, which controls the huge Gander FIR, have supplementary communications and data-linking technologies that help them ensure aircraft maintain required separation standards while under procedural control. These systems include high-frequency (HF) radio voice communication, a growing degree of satellite voice (satvoice) communication and an automated technology called Automatic Dependent Surveillance – Contract (ADS-C).

Unlike ground-based ADS-B that, by receiving ADS-B Out signals broadcast by aircraft, allows active ATM surveillance of all suitably equipped aircraft in line-of-sight range and has a latency (response lag) time of two seconds or less, ADS-C is primarily a routing and timing conformance-monitoring technology that transmits data from aircraft's navigation systems.

Aircraft transmit ADS-C signals to air navigation services provider (ANSP) ground stations, so ADS-C signals are subject to the same line-of-sight range as ground-



The operations room in NATS' Prestwick Centre, which controls the Shanwick FIR and works in conjunction with Nav Canada's Gander Area Control Centre, which controls the Gander FIR, to handle 440,000 transatlantic flights a year. *NATS*

based ADS-B signals. Usually, aircraft transmit ADS-C signals every 14 minutes, but controllers can use ADS-C to query an aircraft's navigation systems more frequently if need be to establish its position relatively closely.

According to Alastair Muir, director of NATS' Prestwick Centre, this capability is called Conformance ADS-C. However, ADS-C has a minimum guaranteed latency of more than a minute, which is inadequate for active ATM surveillance. (ICAO's global ATM surveillance requirement is for a new signal to be received every eight seconds, but the European Organisation for Civil Aviation Equipment's standard is a signal every two seconds.)

The North Atlantic Organised Track System

Today's procedural separation in North Atlantic airspace is complemented by a system of westbound and eastbound tracks that have precisely defined geographical coordinates for reporting waypoints along their routes. NATS and Nav Canada feed aircraft in highly controlled fashion into each of these tracks, each of which covers airspace from 34,000ft (10,363m) to 39,000ft (11,887m), giving each aircraft precise instructions regarding cruise altitude and cruise Mach airspeed, so all aircraft maintain the required separation.

Originally, each track in this North Atlantic Organised Track System (NAT-OTS) was separated by one degree of latitude (60nm/111km), but in May several new tracks were added to reduce the lateral separation of some NAT-OTS tracks to half a degree of latitude, or 30nm (55km). Muir says 25nm (46km) lateral separation of aircraft at the same altitude is allowed on the North Atlantic.

The reason this reduction in latitudinal separation became possible is that in 2011 Nav Canada introduced its new Gander Automated Air Traffic System Plus (GAATS+), the world's most advanced oceanic air traffic management system. In 2014, Nav Canada licensed the GAATS+ system to NATS. Each of the two ANSPs' GAATS+ systems is tailored to integrate with the respective ANSP's automation-platform interfaces and legacy systems, but Muir estimates that NATS' and Nav Canada's GAATS+ systems share 90%-95% commonality.

Their joint use of GAATS+ has also allowed the two ANSPs to reduce longitudinal separation of aircraft on the same NAT-OTS track and at the same altitude from ten minutes to five minutes. This represents a longitudinal separation of about 50nm (92km) on eastbound tracks, in which aircraft fly in a jet stream to benefit from east-flowing tailwinds; and about 40nm (74km) on westbound tracks, which aircraft follow to avoid the easterly headwinds they would encounter in a jet stream.

This system works extremely well for Nav Canada and NATS, each of which hands off control to the other at the 30th meridian west of aircraft leaving its respective FIR. Even today, says Muir, Gander FIR-Shanwick FIR North Atlantic airspace and the NAT-OTS system – used by about 50% of the aircraft crossing the North Atlantic, the other 50% flying on non-standard user-preferred routings (UPRs) – is capable of handling a lot more aircraft per day than it does.

OVERVIEW OF ADS-B



The Iridium NEXT telecommunications-satellite constellation will have 66 satellites (plus six orbiting spares) in moving low-Earth orbits providing orbital coverage of the entire surface of the Earth. *Aireon*

ATM Surveillance Revolution

However, Muir and Rob Thurgur, Nav Canada's vice-president operations, are excited about a radical new ATM surveillance technology the two ANSPs plan to introduce jointly in North Atlantic airspace in February 2018: space-based ADS-B. Nav Canada and NATS expect to sign a joint concept of operations for mutually implementing and using the new surveillance technology in North Atlantic airspace.

According to Thurgur, space-based ADS-B provides a potentially massive opportunity to improve the efficiency not only of North Atlantic airspace use, but also of the individual flight trajectories of every aircraft flying across the North Atlantic. For Nav Canada, the technology potentially also could improve flight trajectories for aircraft flying in remote territorial airspace over far northern Canada and in polar airspace near and over the North Pole.

Thurgur says: "If we can augment our communications protocols along with our surveillance protocols, it provides a huge opportunity to further reduce separation standards, beyond what we're contemplating today. We are in the process of developing an integrated system to allow controllers to use satvoice technology in the same way as they can use VHF voice technology today. It's a little different from today's VHF push-to-talk technology."

Nav Canada initially will focus on implementing space-based ADS-B surveillance in Gander FIR oceanic airspace. However, Thurgur thinks it possible that, one day, using space-based ADS-B surveillance and accompanying it with satvoice technology, Nav Canada will be able to reduce the separation standard in its North Atlantic, remote territorial and polar airspace to 5nm (9km) – the same separation standard it now provides in its controlled domestic airspace.

GAATS+ already allows NATS and Nav Canada to offer pilots step-climb changes in North Atlantic airspace "tactically" – that is, on a case-by-case basis when a pilot asks for a new, higher cruise altitude and the controller calculates the change won't produce any traffic conflicts.

SPACE-BASED ADS-B STATISTICS

440,000 aircraft transiting the Gander FIR-Shanwick FIR North Atlantic routings annually

66 satellites in the Iridium NEXT constellation, plus 6 orbiting spares – all carrying Aireon space-based ADS-B antenna-and-receiver packages

49 data parameters in ADS-B Out 1090ES transponder signal

10 Iridium NEXT satellites carried by each of first 7 SpaceX Falcon 9 booster launches

9 Iridium NEXT satellites built as ground spares

8 firm Aireon customer air navigation service providers, as of May 2016

8 booster launches required to carry constellation of 72 Iridium NEXT satellites to low-Earth orbit

6 orbiting rings of Iridium Next telecommunications satellites, 11 per ring, plus 1 orbiting spare

5 shareholders in Aireon

1.5 estimated number of seconds between an Aireon package on an Iridium NEXT satellite receiving a specific aircraft's ADS-B Out positional signal and the signal being displayed in the relevant Aireon customer's aircraft-tracking system or automation platform

Changing the Game

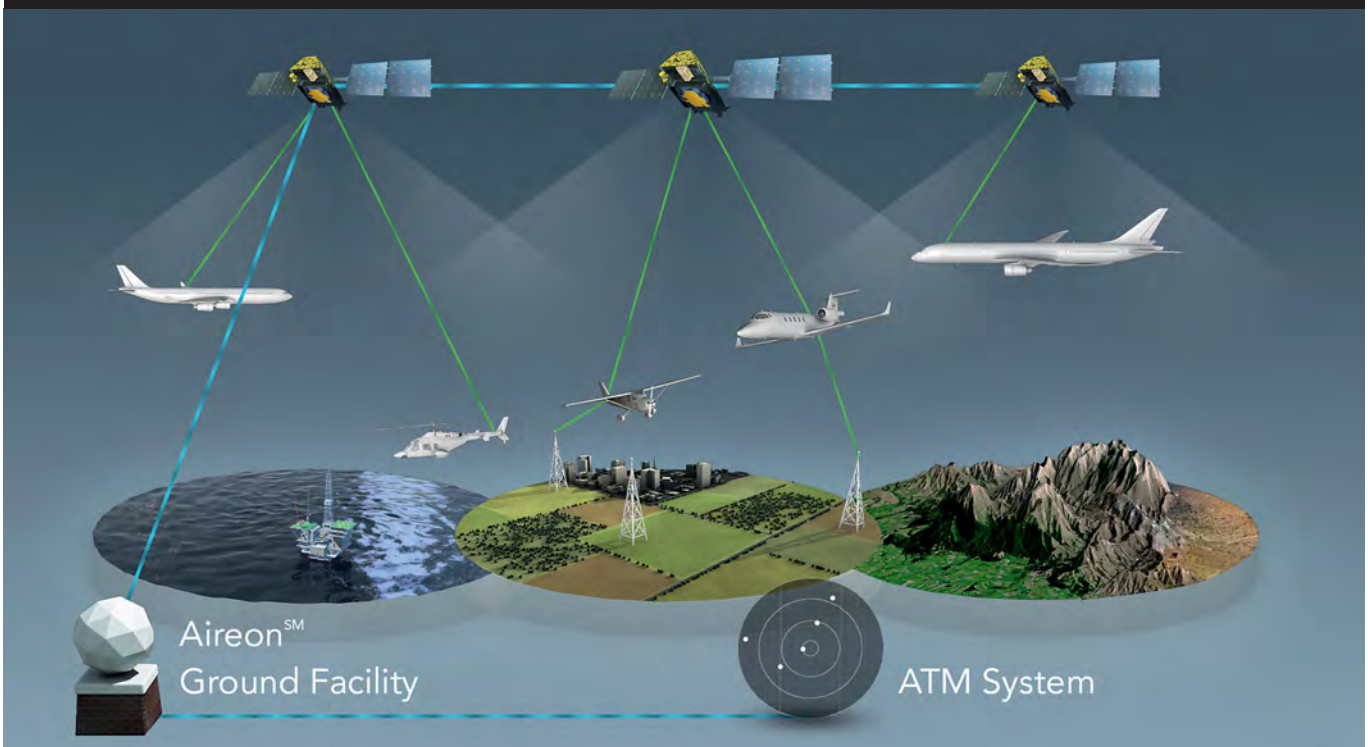
While Muir says the NAT-OTS track structure and North Atlantic procedural control is a "very safe process" and allows "trajectory-based" flying, it does not offer ATM surveillance. However, space-based ADS-B will be "a game-changer", because it will offer active ATM surveillance. When various ANSPs throughout the world introduce space-based ADS-B in early 2018, it will offer ATM surveillance in areas of oceanic, remote territorial and polar airspace to any ANSP, anywhere in the world, which becomes a customer for the service.

Muir says: "The big change with surveillance is predictability, so you can flight-plan in step-climb and Mach changes," into transatlantic flights over the North Atlantic. If enough ANSPs buy the service, the same will apply for flights in oceanic airspace over the Pacific and Indian oceans, the South Atlantic, Africa and anywhere else the space-based ADS-B service is used.

On the North Atlantic, Muir explains: "It is not a capacity change we're after per se." Allowing preprogrammed flight-planning of step-climb changes and variable Mach airspeeds not only will produce average fuel savings "on the order of 400–500lb per flight across the Atlantic", but will also reliably allow operators, when flight-planning any given flight, to reduce fuel uplift, further improving fuel-efficiency and reducing environmentally detrimental emissions.

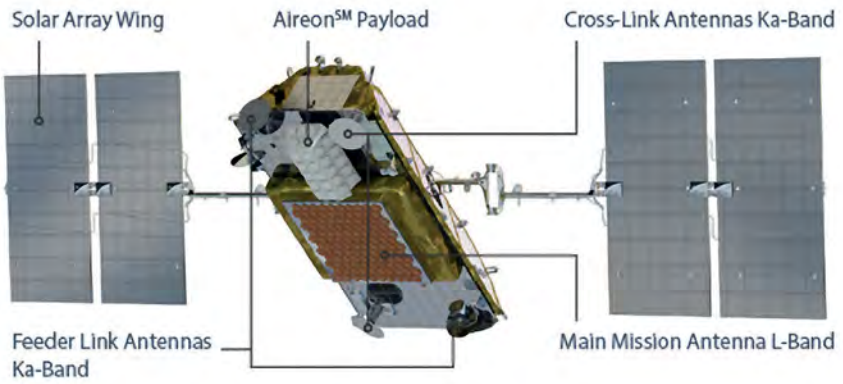
Muir says that it probably will take NATS

OVERVIEW OF ADS-B



Low-Earth orbit Iridium NEXT satellites will receive 49-parameter ADS-B Out signals from equipped aircraft and route them automatically to the nearest satellite to Aireon's ground station. The signals will then be downloaded to the ground station, which will transmit all the signals instantly to Aireon's data control centre. There Aireon will separate the feed into different data bundles for different air navigation service providers. Aireon

IRIDIUM NEXT SATELLITE SPECIFICATIONS



Deployed Wingspan	9.4m
Weight	860kg (approx)
Stowed Dimensions	3.1m x 2.4m x 1.5m

In addition to providing an idea of how large each Iridium NEXT telecommunications satellite is, this diagram clearly shows where the Aireon space-based ADS-B antenna-and-receiver package is located on the satellite's underside.

and Nav Canada "17-18 months to deliver a high percentage of these benefits to our customers", and that "80% of North Atlantic traffic is not all being delivered" by means of space-based ADS-B on day one. However, he says the technology will quickly allow the two ANSPs to reduce today's separation standards in upper North Atlantic airspace to a "15-15" standard: 15nm (27km) longitudinal separation and 15nm lateral separation.

However, Muir and Thurgur caution that every ANSP that employs space-based ADS-B surveillance will have to match the improvements the technology offers with corresponding improvements in controller-pilot data link communications (CPDLC). This will give controllers an automated means of communicating ATM instructions and information to pilots. Because CPDLC is an automated datalink technology, not a means of voice communication, it will not be susceptible to interference resulting from several pilots talking at once – an increasing problem in busy airspace – and correct reception of CPDLC messages by pilots can be guaranteed.

What is Space-Based ADS-B?

The aircraft that have sophisticated GPS and inertial navigation systems – long-range and medium-range airliners and business jets – usually are also equipped with ADS-B Out transponders. These transponders broadcast highly detailed 'extended squitter' (ES) signals, which include 49 different parameters describing an aircraft's identity, flight number, departure airport, destination airport, GPS-derived four-dimensional position in airspace and time, as well as its future positional intent, including heading, track and vertical acceleration.

Broadcasting ADS-B Out signals every half-second on the 1090MHz frequency, alternately from an antenna located on the aircraft's upper fuselage and one located on the lower fuselage, these units are known as 1090ES transponders. Today, when 1090ES ADS-B Out signals are broadcast from a cruising aircraft within 250nm of an ANSP's receiving ground station, air traffic controllers can see the aircraft and know a lot about its flight plan. When aircraft are flying beyond that range, they can't.

Ground-based ADS-B is already in wide use for ATM surveillance in North America, Europe and parts of the Asia-Pacific region. In the United States, the Federal Aviation Administration (FAA) has mandated equipage of all aircraft operating in most US-controlled airspace with ADS-B Out transponders by January 1, 2020. The EU has mandated that all aircraft with maximum take-off weights above 12,500lb (5,669kg) be equipped with ADS-B Out transponders by June 7, 2020. Nav Canada and the Canadian Government are discussing mandating ADS-B Out for all aircraft operating at certain altitudes in Canadian airspace, says Thurgur.

However, the applicability of ground-based ADS-B in oceanic airspace is limited by its line-of-sight distance limitation. Additionally, even though ADS-B ground stations are cheaper than ground ATM radar stations to build, equip and maintain, each costs from $60,000 to $80,000. In remote territorial areas – including much of Africa, Brazil, Russia, western China, central Asia and Australia – constructing networks of ground-based ADS-B stations is not economically viable for ANSPs, argues Cyriel Kronenburg, vice president aviation services for Aireon – which was formed to develop and provide space-based ADS-B.

What if the ADS-B Out signal sent once a second from an aircraft's 1090ES transponder upper antenna is received by ADS-B antennae and receivers mounted on the undersides of communications satellites orbiting in a ring in low-Earth orbit (LEO) hundreds of miles above the aircraft, doing away completely with line-of-sight signal-reception limitations? By receiving ADS-B Out signals from aircraft and then retransmitting them using the satellite's communications-network equipment to a ground station, often routing the signal through other satellites in the ring along the way, so that every ADS-B Out signal is always retransmitted to the ground station from the LEO satellite closest to it, ADS-B Out signals can potentially be received from every equipped aircraft flying anywhere in the world. Also, every ADS-B Out signal can potentially be used to show each individual aircraft's position, accurate to within two seconds or less, all the time.

Aireon and Space-Based ADS-B

This is exactly what Aireon, a five-company joint venture that includes satellite operator and telecommunications company Iridium and the ANSPs Nav Canada (expected to become the majority shareholder of Aireon eventually), ENAV of Italy, the Irish Aviation Authority and Denmark's Naviair, has set out to do. It has developed an antenna-and-receiver package which will be fitted to the underside of each of 72 Iridium NEXT communications LEO satellites to be launched into orbit in a series of eight booster launches from the end of July until late 2017.

The Aireon package – developed by Florida-based communications-technology company Harris Corporation, which has already completed all 72 packages – will receive ADS-B Out signals from the 1090ES

1 From February 2018, Nav Canada's Gander oceanic controllers will be able to provide full air traffic surveillance throughout the entire Gander FIR, all the way out to the 30th west meridian. *Nav Canada* **2** This photo of an oceanic controller's screen clearly shows aircraft using some of the eastbound and westbound NAT-OTS tracks, and some aircraft flying on user-preferred routings. *NATS*

TOP FIVE FACTS ABOUT SPACE-BASED ADS-B

1. About 80% of all the aircraft flying over the North Atlantic fly through both Nav Canada's Gander and NATS' Shanwick FIRs and 440,000 aircraft transit through the Gander-Shanwick FIR system annually. Within 18 months from February 2018, all these aircraft will be actively monitored in real time by air traffic controllers using space-based ADS-B surveillance.

2. Use of space-based ADS-B air traffic management surveillance on North Atlantic routings by Nav Canada and NATS will save every transatlantic commercial flight on those routings 400lb–500lb (181kg-272kg) of fuel, savingairlines hundreds of millions of dollars of fuel costs annually.

3. Because of space-based ADS-B surveillance, airlines and other operators in many parts of the world will be able when planning individual flights to programme optimum flight trajectories and user-preferred routings much more often than now.

4. Svalbard, in the far northwest of the northern coast of Norway, is the extremely remote location of Aireon's space-based ADS-B ground station for receiving downlinked ADS-B Out aircraft signals retransmitted from 72 Iridium NEXT satellites.

5. For preregistered ANSPs and joint rescue organisations that aren't customers for Aireon's live, space-based ADS-B data feed, Aireon will offer a free space-based ADS-B historical data service called Aireon ALERT. In the event of any future MH370-style aircraft disappearance, this service should help authorities to locate a missing aircraft quickly, since Aireon will receive, record and hold in its database all ADS-B Out signals from every equipped aircraft flying anywhere in the world.

transponder upper antennae of aircraft – and often the signals from their 1090ES lower antennae as well, according to Kronenburg. Each satellite-mounted ADS-B receiver will receive signals from a circular area about 1,000 miles (1,600km) in diameter and often more than one satellite will receive a given ADS-B Out signal from a given aircraft.

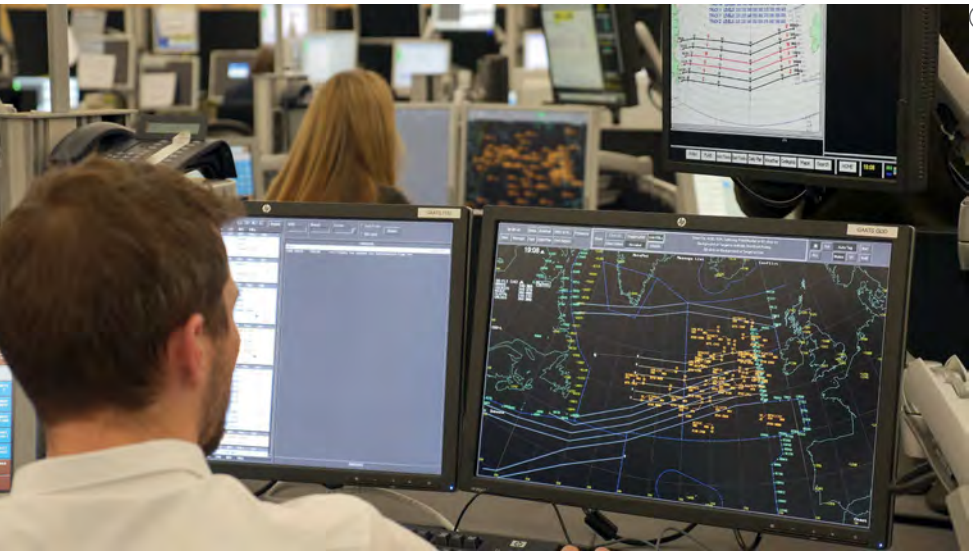
Iridium's NEXT satellite constellation is fundamentally important to the space-based ADS-B technology. The constellation will consist of 66 LEO satellites in six different orbital rings, each ring converging over the North Pole and South Pole. Each orbital ring will have 11 satellites and one orbiting spare, so there will be 72 orbiting satellites. Nine more are being built as ground spares. Each of the first seven satellite-carrying boosters – all of which will be SpaceX Falcon 9 boosters launched from Vandenberg Air Force Base in California – will have a satellite dispenser containing ten NEXT satellites.

Every ADS-B Out aircraft signal received by an Aireon satellite package will be retransmitted using the satellite's onboard communications teleport network. (Each NEXT satellite's teleport network is also capable of receiving and networking CPDLC communications, as well as offering general telecommunications capabilities.) The retransmitted signal will often be routed through other NEXT satellites in the same ring: an ADS-B Out signal from an aircraft flying over the Antarctic may be routed through as many as five satellites before being transmitted down to Aireon's ground station.

This ground station – also now completed by Harris Corp – is located in the Svalbard archipelago, located far northwest of the northern coast of Norway. Not only is Svalbard located near the North Pole convergence point of the NEXT satellite orbital rings, but because it receives no precipitation as rain, the data downlink from the satellites cannot be affected, according to Kronenburg.

All the ADS-B Out signals received by the ground station will instantly be transmitted via a high-capacity data pipe to Aireon's data processing centre in Virginia, also constructed by Harris and also already completed. There Aireon will repackage the overall ADS-B Out data feed into different data bundles, each bundle relevant to the ATM surveillance area covered by a given ANSP customer. Kronenburg estimates that at its Virginia data centre Aireon will receive ADS-B Out signals within milliseconds of their being received by NEXT satellites and the company expects to be able to present relevant bundled signals to each ANSP customer within 1.5 seconds of a satellite receiving it.

End-to-end testing of the system with Nav Canada from an Aireon package on a satellite on its back inside a satellite payload-integration facility near Phoenix recently indicated, inadvertently, that Aireon's space-based ADS-B technology will work well. For the testing, Aireon only planned to use test radio-frequency data; but although the Aireon payload was enclosed within a large metal building, it received live ADS-B Out signals from every equipped aircraft within a radius of 250nm and these were transmitted successfully to Nav Canada's automation platform.

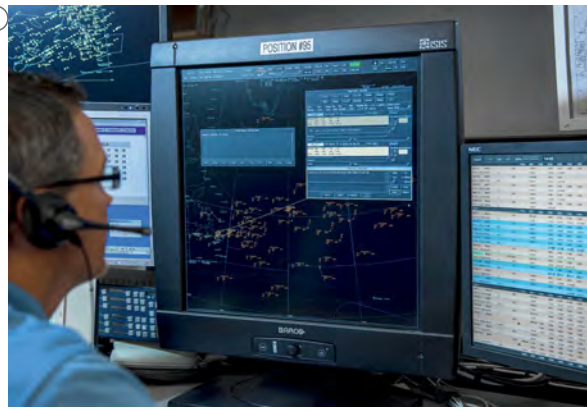


Possibilities for Space-Based ADS-B

Given the NEXT constellation's orbital coverage encompasses every point on Earth, one day Aireon's space-based ADS-B technology could provide active ATM surveillance over the entire surface of the planet, which would make an MH370-style airliner disappearance impossible. However, for fully global coverage, most of the world's ANSPs would have to become Aireon customers. To date, eight have: Aireon's four ANSP shareholders, as well as NATS, the Civil Aviation Authority of Singapore (CAAS), the Dutch Caribbean Air Navigation Service Provider (DC-ANSP, located in Curaçao) and South Africa's Air Traffic Navigation Services (ATNS).

All four non-shareholder customers manage significant amounts of oceanic airspace. CAAS's FIR extends from Vietnam to Indonesia and DC-ANSP's FIR includes much of the upper airspace through which the main ATM tracks between North and Central and South America pass. ATNS controls more than 10% of the world's entire airspace volume.

ATNS is a particularly interesting customer. It will use its space-based ADS-B feed to enhance its existing coverage in the Johannesburg Oceanic FIR covering the southern Indian Ocean and Cape Town FIR covering much of the South Atlantic, as well as its Johannesburg FIR covering domestic airspace. ATNS's space-based ADS-B feed will augment its existing ADS-C coverage in the Johannesburg Oceanic FIR and support UPR operations over both the Indian Ocean and South Atlantic, offering reduced separations.



ATNS will also use space-based ADS-B to supplement its existing terrestrial surveillance coverage and to extend surveillance to terrestrial areas that don't have it now. In this regard, a new regional commercialisation agreement between ATNS and Aireon will see ATNS using its management of the Southern African Development Community (SADC) Very Small Aperture Terminal (VSAT) satellite-communications network to distribute space-based ADS-B data to remote locations. This will extend ATM surveillance to SADC regions where constructing ground-based surveillance stations would be prohibitively costly.

Additionally, ATNS will work with other ANSPs in the region to use space-based ADS-B data collectively to develop a regional traffic flow-control system to complement the existing SADC VSAT network. Regional flow control will result in substantial cost-savings and operational benefits to airlines and ANSPs alike.

Aireon's customer base may grow soon. It has signed memoranda of agreement to explore ATM surveillance using space-based ADS-B data with the ANSPs of Australia, Iceland, India, New Zealand and Portugal, as well as with Dakar-based ASECNA (West Africa's air traffic control agency) and with the Blue Med Functional Airspace Block cooperative. This block includes the ANSPs of Cyprus, Greece, Italy and Malta.

Additionally, Aireon is in discussions with the ANSPs of Brazil, China, Japan, Russia, Seychelles (whose FIR covers parts of the Indian Ocean), most South American nations, and Trinidad and Tobago, whose Piarco FIR covers a vast area of mid-Atlantic and Caribbean upper airspace.

Aireon is now providing test data to the FAA Surveillance and Broadcast Systems' ADS-B feed at the FAA's New York Technical Center. Nav Canada and Aireon are discussing space-based ADS-B use with the FAA's Oakland Air Route Traffic Control Center, which controls a vast area of Pacific airspace along the continental United States and Canada. However, the FAA has yet to decide if it will purchase Aireon's space-based ADS-B feed.



502 Esquadron/Força Aerea Portuguesa

Elefantes

Standing amidst five C295 aircraft undergoing maintenance in Esquadron 502's hangar, one could be excused for thinking the unit is a transport squadron. After all, the C295, built by Airbus at Sevilla-San Pablo, is a twin-turboprop tactical transport aircraft. However, five of the Montijo-based squadron's 12 aircraft are configured to use a roll-on, roll-off mission system, which when fitted enables the aeroplane to conduct maritime surveillance. Looking around the main hangar, one aircraft was configured for maritime surveillance with two radomes, one mounted on the nose and a second under the forward fuselage. Esquadron 502 was formed in 1955 and uses Elefantes or Elephants for its nickname.

Elephant Missions

Discussing the various roles undertaken by the C295, Major Marco Carvalho, Esquadron 502's Commanding Officer, said the aircraft provides national support in transport, medical evacuation (medevac), search and rescue (SAR) and maritime surveillance missions. Medevac and SAR tasking involves one dedicated aircraft held on 30-minute readiness in daytime and 120 minutes at night.

Maritime surveillance sorties are flown on average four or five times per week at varying times of the day over the Atlantic Ocean to the west and southwest of Portugal. Patrols are rarely conducted to find anything specific, but are planned randomly. Explaining the process, Major Carvalho said: "If, for example, we detect pollution on the surface with the SLAR [sideward looking radar] we can see the extent and coordinate with the navy to send a ship to the location to deal with the pollution.

"If we see illegal activity, we remain on scene to capture information while coordinating with the relevant authorities and providing them with the information. We patrol the area out to 10W, and can check ships and fishing boats and how they are working from Africa and the Mediterranean Sea in a five to six-hour window.

Esquadron 502 also flies at least one weekly mission to provide Portuguese Army paratroopers with low-altitude and high-altitude paradrop training.



Mark Ayton reports from Base Aerea 6 Montijo, home of the C295-equipped Esquadron 502, a busy multirole squadron at the heart of the Força Aerea Portuguesa

MISSION SYSTEM AND SENSORS

When configured for the maritime surveillance role, a Força Aerea Portuguesa C295 is fitted with a modular roll-on, roll-off variant of the upgraded version of the Fully Integrated Tactical System called Vigilance Maritime, dubbed VIMAR, which is a mission system applicable to various subsets of surveillance: SAR, maritime patrol, border protection, drug interdiction, immigration control, maritime pollution prevention and the protection of fisheries and economic zones.

The VIMAR system allows tactical operators to control the aircraft's sensors and provides them with real-time tactical and navigation information by interfacing the aircraft's navigation and communication systems using a data management system. According to Airbus, the system also manages aircraft navigation through the creation of a search pattern, guiding the aircraft to emergency locator signals. The information is also shown on one of the four LCD displays in the cockpit. The typical setup for a Força Aerea Portuguesa C295 is two consoles.

The C295's satellite communication suite allows data, images and video gathered by a Wescam MX-15 sensor to be sent to a ship or ground station ashore.

Esquadron 502's aircraft configured for maritime surveillance are equipped with three primary sensors: the Elta ELM-2022A radar; Terma SLAR 9000 side-looking airborne radar; and a Wescam MX-15 EO/IR system.

The ELM-2022A is an all-weather, day and night X-band multimode airborne radar system optimised for long-range maritime surveillance and detection of large targets up to 200 nautical miles (370km), but equally capable of detecting a small target in adverse sea conditions. Elta says the ELM-2022A is capable of automatically tracking all detected targets and penetrating clouds, rain, smoke, smog, fog and manmade camouflage.

In addition to maritime surveillance, the ELM-2022A supports, maritime law enforcement, fishery and economic zone patrolling, SAR, air-to-ground and air-to-air surveillance missions. Modes of operation are: range profiling; inverse synthetic aperture radar, which provides automatic vessel classification at the radar's range in day and night conditions; strip and spot synthetic aperture radar imaging and ground moving target indicator used to provide intelligence, surveillance and reconnaissance support for ground operations; navigation and weather.

The SLAR 9000 is a side-looking sensor capable of searching 25 nautical miles (45km) to the side of the aircraft, which covers a huge area in a short time. All SLAR data are shown in real time with the image in one of two modes: waterfall, in which the aircraft is in the top of the image; or a synthetic map with north up. The tactical operator can zoom, pan and scroll the image, which is fully annotated with data fed by the aircraft's other sensors.

The chin-mounted Wescam MX-15 EO/IR sensor is the primary system used by the tactical operator to detect, classify, identify and track targets day or night.

The MX-15 turret is gyro-stabilised and provides an unrestricted 360° azimuth field of view for all four of its integrated sensors: infrared; continuous zoom TV colour camera; spotter scope monochrome TV camera; and automatic identification system.

In auto-scan mode the turret automatically sweeps the ocean or land surface, at an angle and rate set by the tactical operator. When a target is detected, the MX-15 automatically locks on and starts to auto-track.



1 Esquadron 502 C295 16708 on the flight line at BA6 Montijo. The photo shows one of the Terma SLAR 9000 antennas, the chin-mounted Wescam MX-15 turret, and radomes for the Elta ELM-2022A radar (under fuselage) and the Northrop Grumman AN/APN-241 colour weather radar (nose). *Mark Ayton* **2** The C295 flight deck features four multifunction LCD displays. 502 Esquadron/Força Aerea Portuguesa **3** The C295 features many communication, navigation and flight data systems which are laid out in a straightforward way making the aircraft intuitive to operate. *Ian Harding*

Island Support

Portugal has two autonomous regions comprising two archipelagos located in the North Atlantic: Madeira (970km/600 miles to the west) and the Azores (1,450km/900 miles to the southwest). The Força Aerea Portuguesa operates from Aerodromo Manobra 3 Porto Santo (Madeira) and Base Aerea 4 Lajes (Azores) and retains an EH101 Merlin at each and two C295s at Lajes. Esquadron 502 flies cargo and 20 to 30 personnel to Porto Santo and Lajes on average every 15 days.

The Lajes-based detachment is kept busy with medical evacuation and SAR missions. Medical evacuation sorties are common, because Horta is the only island in the Azores archipelago with a hospital. Last year, Esquadron 502's Lajes-based detachment flew 268 medevac sorties. Many medevac sorties are flown in response to people who have fallen sick or suffered injury on ships underway in the Atlantic Ocean. First response is usually provided by Esquadron 751, the Força Aerea Portuguesa's heavy helicopter squadron, which has an EH101 Merlin based at Porto Santo and Lajes. If a patient requires specialist medical treatment only available on the mainland, Esquadron 502 flies him or her to Lisbon.

SAR missions mounted in response to distress calls from boats, yachts and ships in the Atlantic involve a C295 and a Merlin helicopter, as explained by Major Carvalho: "The C295 takes-off first to find the boat and remains on scene in communication with the boat. Part of the aircrew's task at this stage is to ensure the sick person or people requiring rescue are prepared and ready to be lifted from the deck, and that the boat is turned around in the direction required so the helicopter can hover upwind of the boat for stability. The helicopter is at greater risk when it's slowly manoeuvring close to the boat with a rescue swimmer on the cable. If an accident happens and the helicopter ditches, we are ready to immediately launch life rafts to help the helicopter crew.

C295 CHARACTERISTICS

Crew: *Two*

Capacity: *71 troops*

Payload: *4,000kg (8,820lb)*

Length: *24.50m (80ft 3in)*

Wingspan: *25.81m (84ft 8in)*

Height: *8.60m (28ft 3in)*

Wing area: *59m² (634.8ft²)*

Max takeoff weight: *23,200kg (51,146lb)*

Powerplant: *Two Pratt & Whitney Canada PW127G turboprops each rated at 2,645hp (1,972kW) driving six-bladed Hamilton Standard 586-F propellers*

Max speed: *311kts (576km/h)*

Cruise speed: *260kts (480km/h)*

Range with 3,000kg *(6,600lb)* ***payload:*** *2,500 nautical miles (4,600km)*

Ferry range: *2,900 nautical miles (5,400km)*

Service ceiling: *30,000ft (9,100m)*

Takeoff run: *2,200ft (670m)*

Landing run: *1,050ft (320m)*



2

"It's a complex and expensive mission, because in order for the helicopter to fly up to 350 nautical miles and return, both the C295 and the Merlin are airborne for six hours."

Operating restrictions apply to both the Merlin and the C295. At the airfield of departure, wind strength over 40kts makes landing the C295 challenging. There are only two airfields in the Azores to choose from. According to Major Carvalho, if the pilot is facing a 40kts cross wind it's always challenging to land: "Sometimes we shut the engines down immediately after leaving the runway, because we cannot safely taxi to parking, but there are not many missions like that."

Major Carvalho said ceiling and visibility restrictions limit the aircraft at the scene: "We can work down to 500ft [150m] above the sea level, because the helicopter works at 100 to 200ft [30 to 60m] above the boat; but wind conditions down at 500ft are not a factor, because we are in an orbit."



3

Africa

On January 5, 2015, Esquadron 502 started at two-month deployment to Bamako, the capital of Mali to support United Nations' operations in the African country. The C295 deployment followed a five-month stint by C-130H-equipped Esquadron 501.

Major Carvalho outlined the squadron's preparations: "Once the political decision to deploy the C295 was taken, we started our preparations in October 2014 with the help of the Spanish Air Force to learn from their personnel who had been deployed in Gabon and Senegal with the C295 how they operated and protected the aircraft, and how they undertook their work.

"We took some maintainers and aircrews to Getafe for a few days and



1

had the opportunity to go to Zaragoza to conduct landings and traffic pattern work using an unpaved runway including at night using NVGs [night vision goggles]. We were able to address some short field procedures for the pilots, whether they select reverse or not in order to prevent excessive dust and debris from being ingested by the engines and propellers – small details that if not checked would prevent a mission from being successfully completed. We also undertook protective maintenance on the aircraft, which is key to success in the field."

Esquadron 502 was deployed throughout January and February 2015 undertaking typical transport work in support of peacekeeping operations. The entire deployment comprised two detachments each with two crews and one aircraft. The detachment was tasked to provide medical evacuation 24 hours per day, seven days a week, enabled by its NVG capability.

"We took off from Bamako at 07:00hrs and arrived back at 16:00hrs and flew several flights, a mix of medevac and transport, point to point in between. Some of the locations, like Kidal, Gao and Tessalit, were unpaved landing strips.

"It was really nice for the squadron to use the C295, because it's a new asset for the Força Aerea Portuguesa and was bought to do this type of work; Mali was the first time. We did not lose any UN-tasked missions because of serviceability issues."

The C295 held-up well to the rigours of flying from dusty landing strips around Mali with no serious maintenance problems encountered during the two-month operation. To counter serviceability issues encountered during flight operations, some of the aircrew are also trained to perform certain maintenance procedures such as changing a flat tyre. If a problem develops with one of the aircraft's systems, they are able to troubleshoot the fault, pass details to the maintenance officer at Bamako and arrange to bring spares on another aircraft with other maintainers to help. "Happily such a situation did not happen," said Major Carvalho.

When flying in to Kidal and Tessalit, ground safety procedures were always in place and armed field protection troops were carried on board the C295. All loading and offloading was conducted with both engines running. Such operations are done more aggressively than usual to minimise the risk of attack, dust ingestion and overheating; temperatures on some days were 47°C.

Major Carvalho underlined the importance of having well-trained crew to undertake such an operation and their preparedness to work calmly but fast in such a situation: "It's an important role of this squadron. I have 40 pilots and 44 loadmasters, 16 crews in total, of which four have received specialised training for conducting this type of mission."

During operations at austere locations the aircraft is at most risk during landing and take-off from rockets and MANPADs. To counter such threats, aircrews flew different tactics and used infrared countermeasures to help defeat any shots fired. The C295 defensive suite includes a radar warning receiver and missile approach warning system.

However, Mali was not the first international operation in which Esquadron 502 participated. In 2010, the European Union (EU) agency dubbed FRONTEX (official title the European Agency for the Management of Operational Cooperation at the External Borders of the Member States of the European Union) invited Portugal to join its operations. This resulted in the Força Aerea Portuguesa flying maritime surveillance missions throughout the Mediterranean between May and November 2011 looking for migrant people trying to reach the EU from North Africa and Syria. According to the EU, the agency promotes, coordinates and develops European border management in line with the EU fundamental rights charter applying the concept of integrated border management by helping border authorities from different



Mark Ayton



2



3

EU countries work together.

Operating from Malaga, Spain, the Italian island of Sicily, and Greece, Esquadron 502 flew patrols lasting up to five hours to spot boats underway in the Mediterranean and assess what each boat was carrying.

Major Carvalho recalled how the crews could see the people onboard the boats and expressed the satisfaction felt by the crews who felt they were helping the people: "We carry medical provisions and life rafts and dropped them in the SAR role while waiting on scene to direct naval ships to the position to pick them up. That happened many times."



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Training

Esquadron 502 is a busy squadron with ongoing national tasking and detachments to Lajes. Consequently much of it's proficiency training has to be conducted during other tasking. Pilots follow a six-monthly flight proficiency programme covering all of the unit's mission profiles like SAR, paradropping, special transport and maritime surveillance. Loadmasters, tactical coordinators and pilots all receive a six-monthly check for each mission profile.

"We try to do most training, 80%, on the job because the crew cover so many aspects in normal missions and can be checked by an instructor on board. The other 20% are tactical missions like cargo drops and employing the aircraft's sensors for tactical scenarios and should be certified on training missions," said Major Carvalho.

Major Carvalho said last year's Mali deployment was important for training crews to counter the threat level: "When you operate in a place with a threat level everything is different. It was really important for Portugal to deploy the C295 to Mali to show the aircraft can be used in various scenarios; fly in to places to collect people or insert special forces at night using NVGs. So it's flexible.

"I also want to highlight the search and rescue missions we do with the Merlin, because they are really, really challenging and happen once or twice a month and save lives. Coordination between the helicopter and the C295 in order to provide safety to the Merlin, so it can remain on scene for as long as possible in the area to pick people from a boat and return home, is really important. Everyone is committed to that."



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1 One of Esquadron 502's C295s configured for the maritime surveillance role, serial number 16710, seen at RAF Fairford after its arrival for the Royal International Air Tattoo 2013. *Ian Harding* **2** Esquadron 502 shares it's flight line at BA6 Montijo with the C-130H Hercules-equipped Esquadron 501. Both the C295 and the C-130H shown in this image were ready to launch in the event of an emergency situation. *Mark Ayton* **3** The C295 has a fuselage length of 24.50m and a wingspan of 25.81m. *Airbus* **4** Close-up of the port side SLAR radar antenna. *Mark Ayton* **5** Each six-bladed Hamilton Standard 586-F propeller is driven by a Pratt & Whitney Canada PW127G turboprop rated at 2,645hp (1,972kW). *Mark Ayton*

UK Training



The UK Ministry of Defence has selected the H135M and H145M. Nigel Pittaway reports

On May 20, Airbus Helicopters announced that it had been selected by Ascent Flight Training to provide helicopters for the rotary wing element of the UK's Military Flying Training System (UKMFTS). The company will supply a mix of H135M and H145M helicopters and, in addition, will develop support infrastructure and train the initial flight crews and maintenance personnel.

The contract, which was signed on May 16, is valued at £500 million over 17 years and will see the delivery of 29 H135Ms and three H145Ms to meet the UK Ministry of Defence (MoD) requirements of training 121 pilots and 80 crewmen per year. The first course is currently scheduled to commence in April 2018. The H135M for the UKMFTS contract will be called Juno and the H145M will be called Jupiter, according to reports.

UKMFTS Programme

The Ascent-led MFTS will replace the Defence Helicopter Flying School (DHFS), based at RAF Shawbury, which currently trains rotary wing aircrew for all three services. The DHFS is operated under contract to Cobham Aviation Services and currently flies 37 Airbus Helicopters A350BB Squirrels and 12 Bell 412s.

"This is the final element in re-fashioning the UK Military Flying Training System into a state-of-the-art structure to develop suitably qualified aircrew to secure the future of air elements of the Royal Navy, British Army and Royal Air Force," commented UK Minister for Defence Procurement Philip Dunne at the contract announcement. 1

Ascent, the Training Service Provider, is a 50/50 joint venture between Lockheed Martin UK and Babcock International and the rotary wing aspect of MFTS will run until 2033. Besides Airbus Helicopters as the Aircraft Service Provider, Lockheed Martin Training and Simulation in the US will provide the training courseware under contract to Lockheed Martin UK. CAE of Canada, also under subcontract, will supply (static) simulators and other training aids.

Ascent will provide 25% of the instructors and the balance will be military instructors on a rotational basis from all three services.

The H135Ms will be based at Shawbury, but the maritime training to be conducted

1 The UK MoD has ordered 29 H135Ms to replace AS350BB Squirrels that have been in service since the 1990s. The first helicopter is due for delivery to RAF Shawbury later this year, with the initial course of students starting training in April 2018. All photos Airbus Helicopters **2** The UK MoD's requirement is to train 121 pilots and 80 crewmen per year; the ground training aids will be a key element of their training alongside the aircraft. **3** CAE of Canada will supply static simulators and other training aids, while Lockheed Martin Training and Simulation in the US will provide the training courseware. **4** Three H145Ms are being acquired to replace Bell 212s. The H145Ms will be used for maritime training at RAF Valley.

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g Renewed



on the larger H145M will be undertaken at RAF Valley and a third base will be used as a deployed location. The 29 H135s will each deliver around 850 hours per year, enough for 20 task lines per day overall; and the three H145s will each fly around 860 hours per year, equating to two task lines per day.

Single versus Twin

Ian Morris, Head of Airbus Helicopters' defence business in the UK, said that the twin-engine H135/H145 combination was selected as the most capable, cost effective, solution for the MoD requirements.

"The unit price of a single engine helicopter is cheaper. Single engine – great; engine-off training – not so great," he explained, saying that the DHFS Bell 412 fleet has had no serious incident or accident in 17 years of operations, whereas the single-engine Squirrels have had seven serious accidents and incidents in the same period, all during engine-off training and there was no real engine failure over that time.

"Moreover it drives you into a different way of flying, if you are flying a twin engine aircraft, you can start learning to fly it how you would fly a helicopter in the front line," he added. "The decisions on where you fly, how you fly – speeds, heights etc – are driven more by the tactical environment, because you don't have a problem with a single engine."

Morris also said that because the two Airbus Helicopters products are very similar, a student transitioning from the H135 to the H145 would not have to attend a conversion course in the manner in which students progressing from the Squirrel to the Bell 412 have to today.

"What we tried to do with our solution was to keep everything the same, so you don't have to stop flying, go do ground school and learn how to fly again in a different aircraft, before continuing your training," he explained."The MoD has already assessed the fact that there is no need for a course in between the two aircraft, so people who finish on the H135 can go straight onto the maritime course on the H145."

Helicopter Attributes

The requirements are for helicopters capable of performing basic, advanced and maritime rotary wing training of pilots and rear crew members alone and also together as a crew and covering the entire spectrum of operations, from day visual flight rules through to night instrument flight rules and low-level tactical flying using night vision goggles and an electro-optical system.

Both helicopter types will feature the new Airbus Helicopters Helionix cockpit and in fact the UKMFTS will be the first customer to receive an H135 with the new system. The cockpit is scalable, to tailor the amount of information being displayed to a student's level of capability as they progress through their course.

Some of the equipment specified included a glass cockpit, full authority digital electronic control engines, a four-axis automatic flight control system and moving map displays. Role equipment includes an external hook for underslung load training, a winch and a defensive aids system emulator, which will allow the instructor to inject threat warnings into a training scenario.

"Overarching all of that, the MoD wanted the aircraft to be a civil-certified helicopter which could also meet the equivalent military airworthiness standards to ensure that they can move on to the military register once delivered," Morris said.

Timeline

In June, there were nine H135s destined for the UKMFTS on the production line at Airbus Helicopters' facility at Donauwörth, near Munich. The first aircraft in the contract is due for delivery to Shawbury in October this year. Then the helicopters will be delivered at the rate of between one and two aircraft per month and Airbus Helicopters UK has already begun training an initial fielding team of instructors and maintenance personnel, albeit using a company-owned H135 fitted with the earlier cockpit.

"People ask why we are providing such high-end capability, such as Helionix avionics system and four-axis autopilot in our training aircraft," Ian Morris said. "If you train hard, you fight easy and the idea is to get students used to using all this equipment before they get to the front line."



④

CONECT

A new era for the B-52 started in May 2014 when the first aircraft configured with a digital data suite upgrade, dubbed the combat network communications technology (CONECT) system was delivered to Barksdale Air Force Base, Louisiana for evaluation by the resident 49th Test and Evaluation Squadron.
The CONECT upgrade is the aircraft's first major technology overhaul since 1961, enhancing the aircraft's capabilities.
The system provides increased situational awareness for B-52 crews by adding several communication data links and full-colour LCD displays with real-time intelligence feeds overlaid on moving maps. CONECT also enables future B-52 improvements with its on board, high-speed network with workstations at each crew position, and an integrated digital interphone with increased capacity for expanded voice and data communications.
CONECT has beyond line of sight communications which enables crews to receive targeting and intelligence updates en route to complete final mission planning. A B-52 equipped with CONECT enables theatre commanders based at a CAOC to pass updated threat and targeting data to the aircraft for rapid machine-to-machine retargeting right up to the point of weapon delivery.
CONECT is the digital backbone of the aircraft allowing data to be instantaneously distributed to all members of the crew and presented on new digital displays at each workstation. The digital infrastructure provided by CONECT should enable future upgrades to be integrated on the aircraft. One B-52 programme official described CONECT as taking the aircraft from a rotary-dial phone to a smartphone.
On August 28, 2015 the US Air Force awarded Boeing a $46.7 million contract for seven full-rate production CONECT upgrade kits and 21 retrofit kits to upgrade the examples from the low-rate initial production.
Each B-52H aircraft will be configured with the CONECT system during its four-yearly programme depot maintenance at the Oklahoma Air Logistics Complex at Tinker Air Force Base; a major nine-month period of maintenance requiring nearly 7,000 man-hours to complete. All 76 B-52Hs in service with Air Force Global Strike Command are scheduled to complete the upgrade by 2020; the Oklahoma City Air Logistics Complex can undertake 17 refits per year.
Subject to government funding, further modifications are planned with new Block upgrades which will replace the APQ-166 radar, integrate the AAQ-33 Sniper pod to complement the current AAQ-28 Litening target pod, and fit an extremely high-frequency satellite communications system.

Baltops

Ian Harding spoke with B-52 aircrew at RAF Fairford during deployment to the UK for participation in Exercise Baltops

As the only declared forward deployment base for long range bombers within the US European Command theatre of operations, RAF Fairford in Gloucestershire regularly hosts B-52H Stratofortress bombers.

This year's editions of joint maritime and land-based exercises Baltops and Sabre Strike 2016 once again involved NATO and partner nations training together in the Nordic-Baltic region. Naval warfare was at the centrepiece of the exercises and included the Fairford-based B-52s dropping sea mines at low-level.

Aircraft Participation

Three B-52Hs arrived at Fairford between June 2 and 3, from Minot Air Force Base, North Dakota. All aircraft and the 250 personnel were assigned to the 23d Bomb Squadron, part of the 5th Bomb Wing.

Missions lasting between six and ten hours were flown to the Baltic region on most days of the detachment, some involving two-ship flights.

Colonel Kieran Denehan, Detachment Commander for the 5th Air Expeditionary Group, said the B-52's role in Baltops was to integrate with allied forces in counter sea, maritime interdiction and mine dropping roles. Col Denehan also said the objective for Sabre Strike, primarily a land exercise, was to work with Joint Terminal Attack Controllers and drop munitions to support troops, explaining, "the B-52's dexterity means it can support both exercises".

B-52 Pilot and 5th Air Expeditionary Group Lead Planner, Major Fredo Devito, highlighted how each annual edition of Exercise Baltops builds on the last. He said: "The main aim of Baltops 2016 is to ratchet up integration between NATO's naval and air assets. Practically every nation in the [Baltic] region with a naval force is involved. One of the major challenges for us is integrating so many different nations in different time zones when for many English isn't the first language. In addition to helping nations refine their processes and building the experience of our own aircrews, this year's edition involves the CAOC [Combined Air Operations Centre] at Uedem in Germany which is responsible for binding the maritime and air assets together."

Mission Planning

Speaking to AIR International, 23rd Bomb Squadron Commander Lieutenant Colonel Michael Maginness said: "It's similar to throwing a party in the sense that about three months out you know who's on the guest list and what kind of facility you need. You then call the caterers. Once we knew we were coming and who the main participants were, we determined the footprint; the number of jets, maintenance and munition requirements. As the departure date approaches, we narrow down the times we'll be tasked to fly. Final planning takes place around 24 hours before launch. That's controlled by our mission planning cell. Part of the process involves agreeing to a common set of operational rules so we have ongoing



The 1960s-era B-52H Stratofortress is powered by eight Pratt & Whitney TF33-P-3/103 turbofans. On take-off the engines generate very large smoke trails indicative of the engine designs from the 1960s. Ian Harding



This image: ***A KC-135R Stratotanker assigned to the 434th Air Refueling Wing from Grissom Air Reserve Base, Indiana refuels a B-52H Stratofortress over the Baltic Sea.*** *Senior Airman Erin Babis/US Air Force*
Below left: ***Aerospace repair and reclamation craftsman, place a drag chute into a B-52H Stratofortress at RAF Fairford, following a mission for exercise Saber Strike 16. Measuring 43.5ft in diameter, the ribbon-type chute consists of a pilot chute, long bridle, short bridle, main chute, riser terminal and riser boot.*** *Senior Airman Sahara Fales/US Air Force*

liaison with the different nations and send a squadron representative to each nation who acts as the conduit to feed information back to us."

Swing Role

Explaining the B-52's ability to switch roles during a mission, Lt Col Maginness said: "We always train for multi-role missions, so we may be practising laser-guided bomb drops but also have a targeting pod capability, which allows us to also practise NTISR [non-traditional intelligence, surveillance and reconnaissance] to capture ground imagery, evaluate that imagery and potentially generate targeting coordinates and pass the information on to other platforms. The aircraft has a robust electronic countermeasure suite so we practise countering different threats throughout the electronic spectrum.



"The mind set in the B-52 community is to prioritise whatever conventional mission comes up, whatever we are asked to do that day, we instantly become the expert and there is no room for error. We have to know how each weapon will react in every situation. Our customer this year is the US Navy. It's not every day navy personnel can practise manoeuvres against a large aircraft like ours. Mining is actually one of the less precise things we do because it's a gravity bomb. It's not like a JDAM [Joint Direct Attack Munition] or a laser-guided bomb, both of which use precision."

Mine Drop

This exercise provided a rare opportunity for 23rd Bomb Squadron aircrew to practise dropping Mk62 Quick Strike mines; something aircrew confirmed they get few opportunities to practise in the United States.

The Mk62 is a 500lb (226kg) aircraft laid, influence-actuated bottom mine for use against surface targets in shallow water; a conversion of a general purpose Mk82 bomb. The first mine drop took place on June 11 and involved two B-52s, each carrying six Mk62s loaded in the central bomb bays.

Lt Col Maginness said: "We dropped inert mines from an altitude of around 1,000ft [333m], just off the coast of Bornholm Island, Denmark [which lies to the east of mainland Denmark, south of Sweden in the Baltic Sea], flying in Swedish airspace and coordinating with ships from NATO nations. With no aircraft carrier participating in this exercise, the integration between the air and naval components becomes more challenging as a consequence, because you're not talking with people who talk pure aeroplane. These are things we don't often do, so this mine drop provides us with invaluable experience."

The mine missions were a big deal for the 23rd Bomb Squadron because they involved mine assembly and loading at Fairford. The target time to assemble all components (the bomb body, fuses, and adapter) for heavy munitions like an Mk62 is within seven minutes.

Once assembly is complete, the weapon is delivered to a specialist weapons-loading team for loading on to the aircraft. During Baltops 2016, weapon assembly and loading was conducted in conjunction with US Navy personnel. Specialist Weapons Loader, Airman First Class Jessica Hartwick, explained: "We work in crews of four with a single person overseeing the entire operation including locking in the bomb. The number two supervises and guides where the bomb goes; the number three checks over the bomb to ensure it is safe to be placed on the aircraft and arms it; the number four drives the weapons loader that picks up the bomb and takes it to the aircraft. We drive the bomb on to the heavy stores adapter beam station and the number two will guide the weapon in to bomb racks using the lugs on the bomb. The number one locks the bomb and places the pin in and secures it. Target time for this

operations is three to five minutes".

Planning the mission starts 24 hours before, when the Air Tasking Order is issued. Outlining the challenges of a mine mission, Maj Devito said: "When a B-52 is involved in an operation, the mission generally involves us delivering a bomb to a target. We have to survive [the threats en route] to reach the target which means we have to work hard to align the escorting fighters to clear enemy airspace. Ships involved then play a major role recovering the mines so a two-fold process; drop and recovery. The Mk62 Quick Strike mine has the same characteristics and behaves the same way as a live mine in terms of its airborne release and behaviour through the air except it has a concrete body filled with an inert fuse.

"We can carry 45 in total, 27 inside the bomb bay and nine on each wing-mounted adapter bay. Altitude drop heights vary but generally we like to be lower because the Mk62 mine is not guided; when released they fall to a splash point in the water. Being lower therefore improves accuracy by reducing the impact of external conditions like wind. The success of this mission ultimately relies on the skill of the aircrew to fly and navigate accurately. We can't switch on the GPS and let the mines go. The crew must constantly re-evaluate fixed points and update their navigation models; it's very labour intensive.

"For a live mine drop, we obtain a Mine Field Planning Order from the US Navy which confirms the minefield set up. From this we calculate the points to start and end the release, the intervals at which the mines will come off the aircraft, the speeds we'll fly, all the parameters. You want to fly exactly on the parameters to have the most accurate solution possible. The tolerances required are very tight so this can be a very challenging flight profile while flying at such low level. Our aim is to drop the mines in a straight line so one degree off the heading either way makes a big difference."

Aircrew reconstruct the mission to help confirm where the mines were dropped and to evaluate their success with the navies involved. "We use good old fashioned maths to do that," said Lt Col Maginness.



Left: ***An airman assigned to the 5th Expeditionary Munitions Squadron and a US Navy mineman, cut arming wire on an inert Mk62 Quick Strike mine in preparation for loading on a B-52H.*** *Senior Airman Sahara Fales/US Air Force*

Below: ***Airmen and US Navy minemen assemble inert Mk62 Quick Strike mines at RAF Fairford during exercise Baltops.*** *Senior Airman Sahara Fales/US Air Force*



Best B-52 Ever

Having entered service during the 1950s, it's an incredible thing that the B-52's anticipated out of service date is 2040. "The B-52 is getting better with age," asserted Col Denehan.

Explaining the aircraft's current configuration, Lt Col Maginness said: "Back home, the number of aircraft assigned to the squadron varies between 12 and 14 as aircraft enter preventative depot maintenance and receive upgrades. It is a huge job keeping the fleet serviceable, but our maintainers do an incredible job which is reflected in our mission capable rates. We met all our objectives at Fairford. I've flown the aircraft since 2006: today the B-52 is the most capable it's ever been and is just about to go through another set of upgrades to make it more capable and relevant to today's operations."

In the era of the networked battle space, the greatest challenge faced by the B-52 and its aircrews is integrating with a wider range of troops requiring air support and satisfying their almost unquenchable thirst for information. The aircraft is keeping pace, but its flexibility will be greatly enhanced with the addition of digital connectivity. From an operational perspective, the aircraft is limited by its 488,000lb (1,075,856kg) maximum take-off weight, but with further upgrades, the B-52 will offer even more in combat scenarios.



Maintainers and aircrew of the 23rd Bomb Squadron pose for the author in front of B-52H 60-0037/MT at RAF Fairford. *Ian Harding*

Operational



by Jan Kraak



On June 23, the Armée de l'Air announced that the eight Mirage 2000s deployed to Jordan for Opération Chammal (five 2000Ds and three Ns) are to be replaced by six Rafales by the autumn.

The Armée de l'Air did not communicate where the 12 Rafales for Chammal will be based. The Rafales are currently based in Qatar, but it would seem likely that at least some of the jets will fly from Jordan. French forces have a fully functioning forward operating base in Jordan and have invested in the infrastructure at the base, such as dedicated ammunition storage. As flying from Jordan allows quicker reaction times due to a shorter transit to many of the operating zones, it is likely that some of the Rafales will operate from here.

Mirages Under Pressure

The Armée de l'Air and press alike have discussed the pressure on the Mirage 2000D squadrons for well over a year now; they have been struggling to deliver on all of their operational commitments since they were deployed to Jordan and Niger. Compared to the Barkhane deployment, the fighters assigned to the Chammal force are very busy. From June 29 to July 5 the Chammal contingent flew 38 missions, 32 of which involved delivering ordnance. In the same week, the Barkhane force flew four fighter jet missions.

The Mirages in Jordan fly a lot and the priority in terms of (experienced) crew assignment and maintenance/spare parts for the deployed aircraft has resulted in increased difficulties regarding pilot training and aircraft availability at BA133 Nancy. An Armée de l'Air spokesperson was quoted by the Journal d'Aviation, stating that one Mirage 2000D for Chammal or Barkhane is the equivalent in terms of maintenance of five aircraft at home. According to different sources, the Mirage 2000Ds will have a period of about one year during which they will be back home, but there is no doubt that the deployment schedule will intensify again after that, if not sooner.

Rafale Preference

Increasing the number of Rafales for Chammal was rumoured a few months ago. Besides the availability, crew rest and training issues, the Armée de l'Air supposedly prefers to have Rafales deployed to Chammal as the jet can carry more ordnance and has two engines, which means that there is a reduced chance of crews having to eject over Islamic State-controlled territory. The Mirage 2000D only has one engine, so if it were to have technical difficulties (something that has already happened in the last few years), then the crew's only option is to eject.

The highly publicised cases of the Jordanian F-16 pilot and Russian Su-24 pilots have shown that ejecting in the area of Opération Chammal can have disastrous consequences. As the risks of falling into the hands of armed combatants is a lot less in the Barkhane zone of operations, due to the operations being fewer in terms of volume and more spread out over a much larger area, the Rafales at Niamey in Niger will be replaced by the proven combination of Mirage 2000Cs and Ds. Two of each version will return to Niger when the Rafales leave. The Mirage 2000C does not have a designator pod, which means that it depends on other aerial or ground assets, such as the Mirage 2000D, to designate the target.

Squadron Changes

The four Mirage 2000Ds assigned to Escadron de Chasse (EC) 3/11 'Corse', which is based in Djibouti, have recently returned home to BA133 Nancy after 14 years of continuous deployment in the African country. EC 3/11 was one of only two squadrons within the Armée de l'Air operating a mixed fleet of Mirage 2000s. After the return of the Mirage 2000Ds to Nancy, the Centre d'Expertise Aérienne Militaire (CEAM) at BA118 Mont-de-Marsan is the sole unit to operate



Changes

different types of the Mirage 2000. EC 3/11 continues to operate three Mirage 2000-5Fs on loan from EC 1/2 'Cigognes' at BA116 Luxeuil. It is not known if the air-to-ground gap in Djibouti will be addressed with a temporary or permanent solution in the near future.

The two remaining Super Pumas assigned to Escadron d'Hélicoptères 1/44 'Solenzara' will be sold to Spain. The helicopters should leave for their new home before the autumn. The Armée de l'Air decided to withdraw the small number of Super Pumas based on Corsica, as the maintenance of such a small number of helicopters – all different versions of the Super Puma – was becoming more and more expensive. The SA330B Puma will replace the Super Puma at EH 1/44.

A400M Tactical Capabilities

The Armée de l'Air took delivery of its ninth A400M on June 8. This is the first aircraft equipped with the tactical capabilities that the French fleet has been waiting for quite some time. The ninth A400M (the 33rd built) is capable of airdropping pallets, is equipped with a self-protection suite, can refuel inflight and is capable of refuelling fighter aircraft, as well as transport aircraft. French Defence Minister Jean-Yves le Drian announced in June that the Armée de l'Air should have five aircraft with tactical capabilities by the end of the year: three upgraded aircraft already in its inventory and two aircraft that will be delivered straight from Airbus.

Missiles and King Air 350s

The French procurement agency, the Direction Générale de l'Armement (DGA) released a statement on June 22 explaining that Thales and Sabena Technics will outfit two Beechcraft King Air 350s with intelligence, surveillance and reconnaissance aircraft in the ALSR (Avions Légers de Surveillance et de Reconnaissance) programme. The companies will install equipment such as electronic intelligence, cameras and satellite communications. The French customs agency already operates six King Air 350s. The two further aircraft should be delivered by 2018 and will be operated by the Armée de l'Air.

On July 7, the French Ministry of Defence announced the DGA has ordered development of a laser-guided 68mm missile from TDA Armement SAS, which is a Thales subsidiary. The missile will be developed for the Tigre attack helicopter, which is operated by the Aviation Légère de l'Armée de Terre and should enter service in 2020, at the same time the first Tigre Mk2 should be delivered back to the Aviation Légère de l'Armée de Terre. Besides the heavy-duty Hellfire that was recently ordered for the Tigre, this lighter weapon with metric precision will be the alternative weapon for crews when they have to target moving or static vehicles or small objects. The development of this lighter alternative to the Hellfire is a direct consequence of the reassessment of operational needs, which was part of the 2015 revision of France's Defence Programming Act 2014–2019. The Aviation Légère de l'Armée de Terre helicopters are deployed for Opération Barkhane, where one of the main goals is to disrupt supply routes of armed combatants who often drive pickup trucks in open areas. A smaller and lighter 68mm missile would be an ideal alternative for the heavy-duty and much more expensive Hellfire.

Opposite top: ***One of the final two Super Pumas of EH 1/44 in front of the squadron's hangars in March 2016. The final two will be sold to Spain.*** *All photos Jan Kraak*
Below: ***Except for two aircraft for Opération Barkhane, the entire Mirage 2000D fleet will be stationed on the French mainland for about a year.***



F-35: Requirement Multinational Oper

by David C Isby



The US Air Force's Lockheed Martin F-35A Lightning II is on track to achieve initial operational capability (IOC) by the end of the year, possibly as early as August, Director, F-35 Integration Office, Major General Jeff Harrigian said at a briefing in Arlington Virginia on June 30.

Maj Gen Harrigian's comment followed a ten-day deployment, which ended on June 17, by the 34th Fighter Squadron based at Hill Air Force Base, Utah, involving seven F-35As and 160 personnel to Mountain Home Air Force Base, Idaho.

The squadron achieved all 88 of its scheduled sorties, with only two requiring the use of a spare aircraft rather than the one scheduled to fly the mission. The F-35's troublesome Autonomic Logistics Information System proved to be a non-issue at Mountain Home; there were no unscheduled software mishaps or shutdowns on the ground or in flight. The 34th FS also delivered 15 GBU-12 laser-guided bombs, each one successfully striking its intended target. One GBU-12 missed its target by about 3ft (1m). Some of the weapons were released from an altitude of 40,000ft (12,192m).

The Mountain Home deployment showed what's required for F-35s to deploy in the near future, according to Colonel Max Marosko, Headquarters, Pacific Air Forces, at Hickam Air Force Base, Hawaii: "Commanders must have a good idea of logistics and communications required at a deployed location. With the migration to a just-in-time maintenance architecture, we must have an understanding of how to get parts downrange as we shift to a flexible basing concept of employment [CONEMP]."

Big Needs

A need to understand the F-35's requirements and capabilities is not limited to the United States. The ceremonial rollout at Lockheed Martin's Fort Worth, Texas, facility of the first F-35A Adir built for the Israel Air and Space Force, with Israeli Defence Minister Avigdor Lieberman in attendance, took place on June 22. Israel is the latest nation to gain its first F-35, which underlines Israel's need to integrate the aircraft into its air force, which is currently equipped with advanced but fourth-generation fighters.

Speaking at the Arlington briefing about the operational implications of fifth-generation fighters such as the F-35, Maj Gen Harrigian said: "The Israelis ask us, 'What have you learned? What do we need to be thinking about?' There's lots of tactical information in [US Air Force Manual] 3-1, but for the operational commander wanting to wrap their head around the key issues raised when you get fifth-generation fighters, we found such information was lacking." Maj Gen Harrigian also found the information limitation also included US operational commanders. "[General] Lori Robinson, when she was PACAF commander, was in desperate need to quantify what fifth-generation fighters provided, something she could provide to [international] partners."

Developing a CONEMP

With F-35s being delivered to international air arms and being written into operational plans, the nations involved face a new challenge: the need for a CONEMP to provide operational commanders guidance about fifth-generation fighter aircraft. A CONEMP that will inevitably include US Marine Corps F-35Bs, US Navy F-35Cs and coalition partners' F-35s. Most commanders from all US services and coalition partners are unlikely to be familiar with fifth-generation fighters, their capabilities and their limitations.

This was the subject of a paper written by Maj Gen Harrigian and Col Marosko, both experienced F-22 Raptor pilots, that considered what functional component commanders (leading air or naval forces in a theatre) should be thinking about when they get fifth-generation aircraft in their operational environment. Maj Gen Harrigian says there needs to be an understanding of what fifth-generation aircraft can do, what they cannot do and what is required to sustain their capabilities.



Fifth-generation aircraft are data dependent in a way their predecessors were not, but their capability can provide not just their wingmen but also the entire theatre, with improved multi-domain situational awareness. Deploying and sustaining fifth-generation aircraft, especially if in a scenario involving flexible basing, will be a challenge.

Effective planning for the use of fifth-generation aircraft needs to extend throughout the spectrum of conflict, from relatively permissive but potentially deadly environments such as those encountered by F-22s over Syria, to the intensity of a wider conflict with a near-peer enemy using a wide range of anti-access/area denial capabilities that will likely target forward bases.

ts and rational Integration



F-35A Lightning II 13-5072/HL of the 34th Fighter Squadron at Mountain Home Air Force Base during a seven-aircraft deployment from its home base at Hill in June. Airman Alaysia Berry/US Air Force

A Coalition Air Capability

The need to integrate fifth-generation fighters effectively into joint and coalition air operations is driving the process of bringing the F-35 into operational service. Maj Gen Harrigian said he is leading an effort to establish a process where the vital mission data files (MDFs) of the software-driven F-35 can be rapidly updated and shared with coalition partners to ensure all F-35s operating together will have the same situational awareness. Maj Gen Harrigian said if a flight of US Air Force F-35As is flying a combat mission, it needs assurance it can share the same situational awareness as UK F-35s operating in the next lane.

For the US Air Force to declare the F-35A-equipped 34th Fighter Squadron as IOC, the service will be required to have MDFs configured for two different theatres. The software laboratory at Eglin Air Force Base in Florida is being set up so it will be able to update MDFs rapidly for US and international F-35s alike in an operational environment.

However, generating a uniform MDF for all international F-35 users in a single theatre remains problematic. Some international users will not use threat data at the core of an MDF without knowing its source, which may not be releasable. Israel is one nation that reportedly wants to be able to generate its own MDFs using its own unique inputs.

To enable this capability will require not only effective procedures for data release between international users, but also full use of the F-35's inherent defences against cyber and electronic attack techniques. Resistance to such attacks, Maj Gen Harrigian said, cannot be effectively provided by appliqué solutions, but rather "has to be baked into the platform" and will "enable them to go to places fourth-generation aircraft can't go".

Next Steps

The achievement of IOC by the 34th Fighter Squadron is seen as an objective milestone of success for the long-running and expensive F-35 programme, but in reality it is a first step, rather than the last. Operationally integrating not just US F-35s, but also those of international users, into potential theatres of operation worldwide will not be a straightforward process.

Overcoming



Investigating and then resolving engine issues has severely curtailed deliveries of A400Ms. Priority has been given to modifying the engines of in-service aircraft, meaning that deliveries will continue to be disrupted for some time.
All photos Airbus Defence and Space

Airbus Defence and Space has faced what one senior executive described as a "tsunami" of problems with the company's innovative A400M heavylift tactical transport aircraft. However, seemingly like everyone connected with the programme, he retains absolute confidence in the aircraft, and remains optimistic that current problems are all on their way to being solved, and that future prospects for the aircraft are extremely bright.

This is hardly surprising, given the aircraft's tremendous capabilities, impressive performance and its record in service, which has already started to win it the affection of its pilots and crews. Seasoned observers of air power affairs cannot remember a transport aircraft offering such a quantum leap in capability compared to the aircraft that have gone before, while Boeing's failure to keep the C-17 Globemaster III production line open has effectively left the aircraft without anything approaching a direct competitor. Against all this, the A400M's recent problems can be placed in context, and can be seen for the relatively trivial and insignificant obstacles that they are.

Problems

But with that said, the aircraft has indeed suffered a succession of problems and difficulties, including excessive airframe weight, poorer than forecast payload, cost increases and delays (which in turn led to order reductions and the withdrawal of South Africa from the consortium). The aircraft suffered cracking of the Europrop International (EPI) TP400 propeller hubs in 2009 to 2010 and manufacturing faults (involving a specific heat treatment process) adversely affected the strength of the ring gear in a batch of 14 PGBs (propeller gear boxes) produced in the first half of 2015. But new problems have continued to emerge and there can be no doubt that the last 12 months or so have been something of an annus horribilis for the A400M.

On May 9, 2015, Airbus A400M Atlas MSN23 (scheduled to be the third A400M for the Türk Hava Kuvvetleri Turkish Air Force) crashed near Seville Airport during its first pre-delivery test flight, killing two pilots and two flight test engineers of the six crew onboard. This set deliveries back as the causes of the accident were investigated. The crash was eventually attributed to the full authority digital engine control being unable to read engine sensors due to an accidental file-wipe, leading to three of the four propeller engines remaining in 'idle' mode during take-off.

the Tsunami

Jon Lake reports on the various challenges Airbus Defence and Space has had to overcome on the A400M



Though an international aircraft programme is bigger than any one man, there was no doubt that the programme team suffered another shock when former Chief Test Pilot Ed Strongman, a highly experienced test pilot and a charismatic and hugely respected evangelist for the aircraft, died of cancer on March 27, 2016. Strongman had captained the first A400M flight on December 11, 2009 and was deeply involved in the systems and quality development that led to the A400M receiving its EASA Type Certification on March 14, 2013. Though Strongman had retired in November 2014, his death came as a real blow to morale.

Power Gearbox

Following an engine failure after take-off on a Royal Air Force A400M in January 2016, inspections revealed that some of the engines on some aircraft were suffering cracks to an input pinion plug within the power gearbox module of the TP400 engine.

The PGB (produced by GE Aviation-owned Avio Aero in Italy) converts the high RPM of the engine turbine into a slower rotation to drive the propeller. The cracking only affected the input pinion plugs of gearboxes on engines whose propellers rotated clockwise.

EPI and Avio Aero identified the root cause of the problem, and came up with an inspection regime while developing an interim fix. Each gearbox is being inspected every 200 hours, and if a crack is found then the affected gearbox is inspected every 20 hours in order to keep aircraft flying.

Investigating and then resolving these engine issues severely curtailed new aircraft deliveries and limited flying by the 27 aircraft that had been delivered to date since priority was given to modifying the engines of in-service aircraft, meaning that deliveries will continue to be disrupted for some time.

A400M development aircraft MSN6 is flying with the interim 'fix' (an adapted version of the pinion plug) developed by EPI and Avio Aero. This has been applied to the two clockwise rotating engines which have now logged more than 100 flying hours. Engineers from Airbus Helicopters with long experience in gearboxes are reportedly helping with developing a long-term solution. Airbus gained certification of the interim fix on July 8. Aircraft fitted with new adapted pinion plugs will be first inspected at 650 hours and every 150 hours thereafter. A long-term solution of a new gearbox from General Electric and Italian subsidiary Avio is expected to be delivered next year.

Since then, it has been revealed that the first two German A400Ms (54+01 and 54+02, both delivered in December 2014) had been temporarily grounded after inspections found heavy engine wear in the clockwise rotation PGBs. Similar wear was also discovered on Germany's third A400M.

Fuselage Frames

Another problem was discovered during inspection of a French A400M. Some fuselage frames around the wing box made from a particular alloy (786) were found to be cracking. These cracks do not affect flight safety and a repair scheme has been incorporated into regular maintenance and upgrade schedules. The alloy will not be used in aircraft built from MSN70 (due to come off the production line in 2017). A plan to replace the frames retrospectively from existing aircraft is now being defined.

But as well as solving recently discovered issues, Airbus Defence and Space is working hard to address long-standing issues, including the slower-than-planned incorporation of tactical capabilities. These will now be incorporated in a two-step programme, with step one providing for the air delivery of eight tonnes of cargo, with cockpit armour, Cat 3 Autoland, air-to-air refuelling receive capability; and defensive aids including installation of a missile approach warning system, a radar warning receiver and chaff/flare dispensers. The first aircraft with step one capabilities incorporated was delivered to the Armée de l'Air took (its ninth A400M) on June 8.

Step two will allow air dropping of up to 24 tonnes, and paratrooping. Dropping paratroopers simultaneously from both side doors is a key capability, but one that was initially difficult to certify, thanks to a risk of the paratroopers hitting the parachute bags that remain attached to the aircraft. Modifications will separate the paras from the fuselage sides, and the company hopes to certify the aircraft to drop 58 paratroopers from each side of the aircraft. Certification is achieved in increments of five paratroopers, and the aircraft is now certified for 25 per side.

Another problem has been the failure to certify the A400M to refuel helicopters in flight. Proximity trials demonstrated that with the standard 80ft (24m) hose, the receivers were in too close proximity to the A400M's tail. The solution is to extend the hose to 120ft (36m), but this will mean less rigidity, so a smaller diameter hose will have to be used – giving lower flow rates. Tests of a new hose are expected later this year, and the eventual solution could involve the use of two different pods for helicopter and fixed wing receivers.

It looks as though now, after a difficult time for the programme, Airbus Defence and Space seems to be on top of the problems, working on real long-term solutions. As a result, senior programme insiders are optimistic about the future, and bullish about the aircraft's prospects. Some have even started talking about sales to the US Department of Defense, arguably the hardest market for a European manufacturer to crack.





Above: ***Despite the problems that have affected the A400M, the aircraft's capabilities and service record has already started to win it the affection of its pilots and crews.*** *A Tchaikovski/ Airbus Defence and Space*
Top: ***An A400M dropping paratroopers at Tarbes, southern France. Qualification of the aircraft for dropping paratroopers is part of a two-step programme to address issues over the aircraft's tactical capabilities.***

Following an engine failure after take-off on a Royal Air Force A400M in January 2016, inspections revealed that some of the TP400 engines on some aircraft were suffering cracks to an input pinion plug. Europrop International and Avio Aero have developed an interim fix to the power gearbox problem, and each gearbox is being inspected every 200 hours.





The first A400M for the Ejercito del Aire (MSN44) after leaving the Seville Final Assembly Line ahead of its first flight.

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